TRANSACTIONS

OF THE

AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

VOLUME XXIII

TRANSACTIONS

OF THE

AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

Forty-second Annual Meeting, held at
French Lick, Indiana

May 22, 23 and 24, 1930

Volume XXIII

Published for the Association by
The Bruce Publishing Company
Saint Paul and Minneapolis
1930

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THE AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

FIRST DAY, MAY 22, 1930

ANOMALOUS RENAL ROTATION AND ASSOCIATED ANOMALIES

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The various anomalies of the kidney, and their clinical significance, have been widely discussed in recent years and many data of great clinical value have been advanced. Although the various renal anomalies in regard to form, position and number have been described by many authors, anomaly of rotation has been only briefly referred to. I have observed a number of cases in which anomalous position and form of the renal pelvis was the most prominent, and in some cases the only, clinical evidence of abnormality, and it is my purpose to consider this anomaly.

Concerning renal embryology, it may suffice to recall that when the fetal kidney first assumes its definitive form it is situated in the caudal area of the embryo, and during the fifth and sixth week is situated adjacent to the aorta, where it divides into what later become the iliac arteries. Its blood supply is derived from adjacent blood vessels, and the pelvis and ureter are on the anterior surface of the kidney. As the kidney ascends, it leaves its former arteries behind and acquires new vessels, more closely adjacent. This is repeated in its upward progress, and its manner of ascent has been referred to as similar to climbing a ladder. During the seventh or eighth week, as the kidneys ascend, they slip over the aortic bifurcation and immediately begin to rotate so that the convex border eventually assumes a lateral position and the pelvis is situated

mesially. The calices extend laterally and the ureter leaves the pelvis from its lower median border.

Abnormal rotation of the pelvis is variable in degree and may be described by the terms failure, incomplete, reverse and excessive. It does not necessarily involve the entire kidney, but may be confined to one pole and may affect only a segment of the pelvis and the adjacent calices. It may occur either as the result of congenital or acquired factors. When it is of congenital etiology, it is referred to as anomalous rotation. Abnormal rotation secondary to acquired factors is best

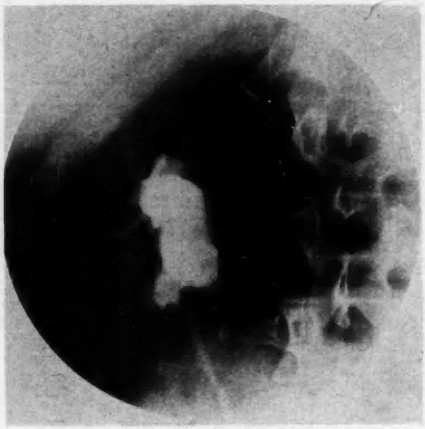

Fig. 1. Right half of horseshoe kidney with failure of rotation, as shown by the anterior pelvis and calices.

designated by the term renal torsion. Anomalous renal rotation may occur either with or without any other evidence of congenital anomaly. It is most frequently observed with some other form of renal anomaly, such as fused or ectopic kidney.

FUSED KIDNEY

In fused kidneys, evidence of abnormal rotation always is found, at least in one pelvis, and usually in both. In fact, clinical recognition of fused kidney is made possible largely

by the demonstration, in the pyelogram, of failure of pelvic rotation. This has been noted by various observers. As a result of inability on the part of the fused kidney to rotate, the renal pelves remain situated on the anterior aspect of the kidney. In the pyelogram the outline of the pelvis is variable, often with evidence of sacculation, and at times it is linear. The calices usually extend anteriorly, mesially or laterally, and often are clubbed terminally. The ureteropelvic juncture may be situated

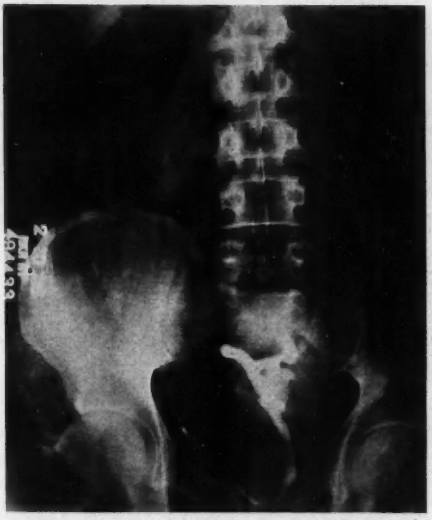

Fig. 2. Ectopic kidney with failure of rotation, as shown by abnormal axis of calices.

either on the anterior aspect of the pelvis or on its lateral or mesial border.

There may be some difficulty in distinguishing between fused kidney and simple anomaly of rotation, particularly if both pelves are involved. As a rule these two conditions can be recognized in the urogram by the distance separating the two pelves, since with fused kidney this distance is abnormally short. Occasionally this may be misleading, however, since renal fusion has

been observed when the interpelvic separation was so great that fusion would seem impossible. The renal outline in the original roentgenogram, although not always distinct, frequently is of much diagnostic value in these cases, and usually offers evidence sufficient either to suggest or to exclude fusion. If both poles of the two kidneys are definitely outlined and are seen to be situated in the normal position, fusion is hardly possible. With unilateral fused kidney the pelves are usually more abnormal in outline and rotation than with bilateral fusion. The lower pelvis often is elongated and linear in outline, and its axis may be horizontal rather than vertical.

ECTOPIC KIDNEY

Failure of the embryonic kidney to make its normal ascent results in congenital renal dystopia or ectopic kidney. The kidney usually is abnormal in form and structure, and, as a result of failure of rotation, the pelvis is situated anteriorly and is bizarre in outline. The renal blood vessels are usually abnormal in number and arrangement and often influence the anomalous shape and position of the kidney and its pelvis. Failure of rotation has been attributed to the fact that the kidney is situated at a level below which rotation of the ascending kidney is supposed to take place, and in some cases possibly it is hemmed in by adjacent and aberrant blood vessels. The contention that renal rotation does not occur until the fetal kidney has reached a certain level in its embryonic ascent is disproved by the fact that normal rotation occasionally is observed with extreme congenital dystopia, even when the kidney is as low as the caudal sacral vertebræ. The kidney may be regarded as ectopic when it is situated at any level below the normal level of the second or third lumbar vertebræ. When the ectopic kidney is situated above the level of the iliac crest it may be difficult to distinguish it clinically from acquired renal dystopia or ptosis. Torsion resulting from renal ptosis may cause the renal pelvis to assume a position and outline simulating that which occurs with congenital failure of rotation. As a rule, however, the pelvis with acquired ptosis can be recognized by the absence of the

other characteristics of renal anomaly. With ectopic kidney the pelvis usually is anterior and, like that in the fused kidney, often appears to be slightly sacculated and may be bizarre in outline. The calices may extend anteriorly, or mesially and laterally, and there is often a tendency to duplication.

ANOMALY OF ROTATION ONLY

When renal anomaly is characterized only by anomalous rotation the degree of rotation may vary and can be described by

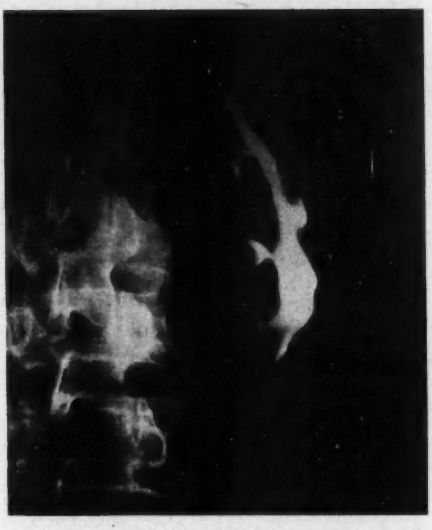

Fig. 3. Anomalous rotation with normal relation of calices, pelvis and ureter reversed. Embryologic type of pelvis.

the terms rotation absent, incomplete, excessive or reversed. Although the pelvis may be in a normal position, it is more frequently observed with either lateral or mesial displacement or with slight ptosis. It is usually situated on a level with the second lumbar vertebra. It may, however, be slightly lower and is then distinguished from ectopic kidney by the fact that its blood vessels take origin at the usual level of the renal artery

and vein. With failure of rotation, the pelvis lies on the anterior surface of the kidney, as in the embryonic state. With partial or incomplete rotation, the normal axis of most of the calices, and the normal relation of the pelvis and ureter are retained, although several of the calices may remain anterior. In many instances the normal relation of the calices to the pelvis and ureter will be found to be reversed: the calices extend mesially

Fig. 4. Anomaly of rotation, reversed type, confined to left side. Embryologic type of pelvis with tendency to duplication.

and the ureter has its origin on the lateral border of the pelvis instead of the mesial border. This form of rotation is opposite to that observed with the normal kidney and may best be described by the term reversed rotation. With these changes there may also be unusual outlines of the pelvis or calices, sacculation of the pelvis, and other deformity characteristic of the embryonic pelvis. In rare instances, the rotation is excessive and progresses to such an extent that the pelvis is situated pos-

teriorly and the convex border of the kidney extends anteriorly. It is obvious that the clinical diagnosis of anomalous rotation is possible only by means of pyelography. Although evidence of anomalous rotation may be confined to one kidney, there is often some minor evidence of anomaly in rotation, either in the contour of the pelvis or in one or more calices in the opposite kidney. It frequently involves only one of duplicated

Fig. 5. Anomaly of rotation, reversed type, with slight clubbing of calices, suggestive of moderate stasis.

pelves, usually the lower. It will be necessary to distinguish this condition from renal anomaly in which failure of renal rotation occurs secondarily. Evidence of renal rotation may be observed with clinical conditions in which it may be difficult to determine whether the rotation was primary or secondary. This is illustrated by a recent case, in which intermitten hydronephrosis was found on surgical exploration. The kidney was rotated in such a manner that obstruction apparently had resulted

from pressure on the pedicle by anomalous blood vessels. It was difficult to determine whether the rotation was due to torsion or was caused by anomalous failure of rotation. The outline of the pelvis and calices was suggestive of an embryonic pelvis.

TORSION

Abnormal rotation of the kidney frequently is observed as the result of other than congenital factors, and may be best

Fig. 6. Renal torsion (acquired rotation) as result of pressure by retroperitoneal mass.

referred to by the term renal torsion. This condition is an acquired one and may result from: (1) displacement from either extrarenal or intrarenal pathologic conditions, such as neoplasm, infection and pyelectasis; (2) renal ptosis; (3) postoperative deformity, and (4) injury.

As a result of torsion, the kidney may be displaced in any direction and its axis changed to various angles. The pyelogram usually will reveal pelvic rotation, varying from a slight

difference in the axis of one or more calices to complete reversion of the pelvic arrangement. It may be difficult to distinguish anomalous rotation from that occurring secondary to torsion. I distinctly recall a case in which there was excessive rotation of the kidney, so that the normal axis of the calices, pelvis and ureteropelvic juncture was completely reversed in both kidneys, and a clinical diagnosis was made of bilateral anomalous renal rotation. On surgical exploration, extensive retroperitoneal lymphosarcoma was found, which had displaced the kidney in such a manner that its normal relation to surrounding tissues was completely reversed. As a result of a marked degree of renal ptosis, or from displacement by extrarenal tumor, the renal pelvis may assume a position and contour very suggestive of ectopic kidney. To increase the difficulty of diagnosis, slight dilatation of the calices and mild pyelectasis, which frequently is observed with marked ptosis, might be confused with similar changes often observed in the embryonic pelvis. Displacement by extrarenal tumor may not merely push the kidney down to the level of the iliac crest and over the spinal column, together with marked rotation of its pelvis, but it may cause so much pressure on the renal pelvis that the kidney will become flattened and elongated. As the result of perinephritic abscess or postoperative cicatricial changes, the axis and contour of one or more calices only may be affected by torsion, whereas the remaining pelvis is normal. With anomalous rotation in one kidney, some evidence of anomaly in rotation or contour of the pelvis or calices is frequently found in the other kidney and always should be looked for in cases in which the distinction between congenital and acquired rotation is doubtful.

EMBRYONIC PELVIS

In the course of pyelographic examination a renal pelvis occasionally is observed which has a shape suggestive of congenital deformity and which has been termed an embryonic pelvis. Its outline is characterized by an elongated pelvis, from which a series of abbreviated calices extend laterally, anteriorly, or mesially, at comparatively regular intervals. It may be asso-

ciated with a variable degree of abnormal rotation. The pelvis may appear to be sacculated and may be suggestive of a mild degree of pyelectasis. Apparent dilatation of the pelvis, which frequently is observed with various forms of renal anomaly, has been attributed to various causes. It may be explained in some cases by mild obstruction from anomalous blood vessels. The possibility of atonic pyelectasis, similar to the ureterectasis fre-

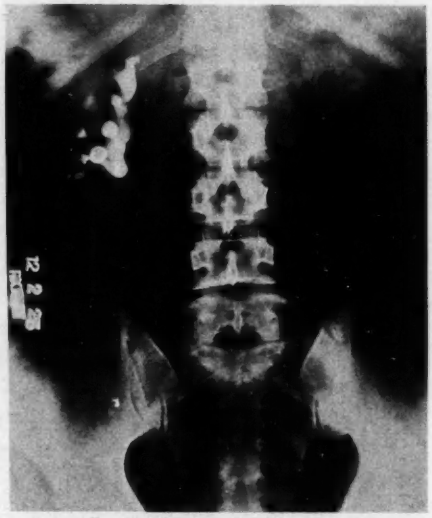

Fig. 7. Embryologic pelvis with incomplete duplication, as shown by anterior calices. Segmental arrangement of calices corresponding to fetal lobulation.

quently observed in the fetal ureter, also must be considered. A calix larger than the others usually extends vertically from the cephalic end of the pelvis, and it may be so situated and elongated as to suggest incomplete duplication of the pelvis. The other major calices have short infundibula, and are abbreviated and small, branching immediately into minor calices. The minor calices are frequently large, and give the impression of clubbing. It should be noted, however, that the bizarre pelvic

outline may be more apparent than real, owing to the fact that as a result of torsion the roentgenogram may be made from the cortical aspect and not from the normal lateral position.

Although the kidney is sometimes normal in position, there may be a variable degree of dystopia, and there is usually some evidence of incomplete rotation. On surgical exploration, the kidney usually is found to be abnormal in shape and size. It may be comparatively elongated, and often there is marked evidence of fetal lobulation. As with other forms of renal anomaly, fetal kidney frequently is associated with other congenital defects, such as duplication of the pelvis in the other kidney, spina bifida occulta, genital anomaly, and constitutional inferiority.

TREATMENT

It is known that an anomalous kidney is more often affected by pathologic complications than a normal kidney. Hydronephrosis and stone are the lesions most commonly found and may be the direct results of anomaly. Symptoms suggestive of nephralgia frequently are associated with anomalous renal position. Given evidence of anomalous rotation, without other pathologic change in the pelvis, the question may arise whether the renal condition might be the source of abdominal pain for which the patient presents himself. There may be but little evidence of pyelectasis in the pyelogram, other than the minor or moderate degree of pelvic sacculation or clubbing of calices frequently observed in the so-called congenital pelvis. In some of these doubtful cases at surgical exploration the kidney was found to be bound down by aberrant blood vessels and surrounding tissues in such a manner that urinary drainage might well be interfered with at intervals and function hampered. In several cases it could be inferred that the pedicle may have been temporarily under tension. Suffice it to say that, when the kidney was thoroughly freed, in many instances the symptoms ceased. Removal of obstructing factors, such as nephropexy, plastic operations, or nephrectomy, may be necessary to correct the anatomic conditions which occur with anomalous rotation and associated lesions.

SUMMARY

Anomalous rotation is apparently an important etiologic factor in the pathologic complications which frequently occur with renal anomaly. It is most frequently observed with renal fusion and congenital dystopia, although it may occur without any other evidence of renal anomaly. It may be the cause of urinary stasis and pyelectasis with resulting renal pain, and may be regarded as a distinct clinical lesion.

Renal rotation secondary to acquired factors is distinguished by the term renal torsion. It usually can be recognized clinically by the absence of other evidence of embryonic deformity.

A sacculated, elongated pelvis, with multiple abbreviated calices extending laterally, and an elongated cephalic calix, are the characteristic features of the so-called embryonic or congenital pelvis.

Nephralgia of obscure etiology frequently is observed with anomalous rotation, although surgical exploration may disclose little evidence of gross pathologic change other than anomaly.

UNUSUAL DUPLICATION OF RENAL PELVIS

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It has been considered that when there is duplication of the renal pelvis one pelvis is invariably situated above the other. That the division might occur in the longitudinal axis instead of in the transverse axis was not considered until recently. A

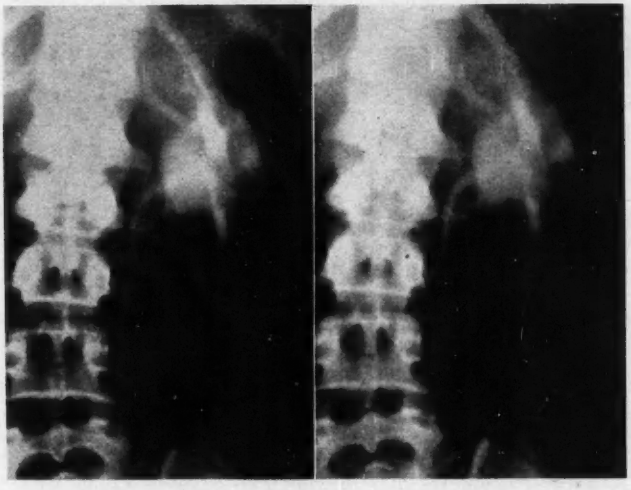

Fig. 1. Unusual duplication of the renal pelvis.

pyelogram made at The Mayo Clinic in August, 1928, suggested that one pelvis might be in front of the other, due to longitudinal instead of transverse division. That the condition might be one of supernumerary kidney was considered, and Kretschmer's report of the thirty known cases of supernumerary kidneys read before this association last year was carefully reviewed. The case might better be classified, however, with one

reported by Potter and Sexton. They stated: "According to Young, the pelves of the double kidney are always situated one above the other, the division being transverse. We believe the division may be longitudinally through the kidney with one pelvis anterior and one posterior and . . . . . we show what we believe to be such a condition."

The patient seen at The Mayo Clinic in whom the unusual duplication of the renal pelvis occurred was a woman, aged thirty-

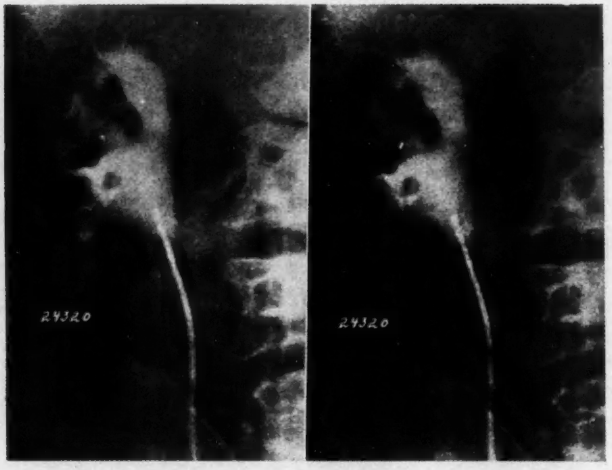

Fig. 2. Normal right pyelogram.

six years, who complained of pain in the right lower quadrant of the abdomen and in the legs and arms. She stated that the pain had been present since childhood and that during the last year it had been associated with stiffness and pain in the ankles and knees. Since her last menstrual period three weeks before her admission she had had considerable pain in the right lower quadrant, which she believed was associated with fever. The pain was of a dull aching character.

The patient weighed 120 pounds. The general examination gave negative results. A passed specimen of urine contained 8 pus cells to the microscopic field. A roentgenogram of the

urinary tract disclosed a shadow on the right side of the ischium which was interpreted as a probable phlebolith.

Because of the pain on the right side a cystoscopic examination was made, and for some unexplained reason a pyelogram (Fig. 1) of the left kidney, rather than of the right, was obtained. The urine from the left kidney was free from infection. The pyelogram was developed and the evidence of the two pelves, one anterior to the other, was noted. A pyelogram of the right kidney was obtained three days later (Fig. 2) and indicated that this kidney was normal. At the time the pyelogram of the right kidney was made, the functional test of each kidney separately was carried out. There was a 10 per cent return of dye from each kidney in fifteen minutes. The specific gravity of the urine was 1.009.

BIBLIOGRAPHY

1. KRETSCHMER, H. L.: Supernumerary kidney: report of a case with review of the literature. Surg., Gynec., and Obst., 49:818-831 (Dec.), 1929.
2. POTTER, R. P., and SEXTON, W. G.: Anomalies of the ureters and the kidney pelves. Radiology, 12:199-206 (Mar.), 1929.

CALCIFICATION WITHIN THE TUBULES OF THE KIDNEY IN ASSOCIATION WITH URINARY TRACT LITHIASIS

E. GRANVILLE CRABTREE, M.D.

From the Urological Service of the Beth Israel Hospital, Boston

The use of X-ray and fluoroscopy of kidneys in the wound at the time of operation has placed a heavier burden on the operator. There is no doubt that by this means small calcifications are noted which are not shown in the roentgenograms taken in the routine way. Without such X-ray many of these small calcifications remain unrecognized, either to pass spontaneously or to remain and serve as a basis for recurrence of

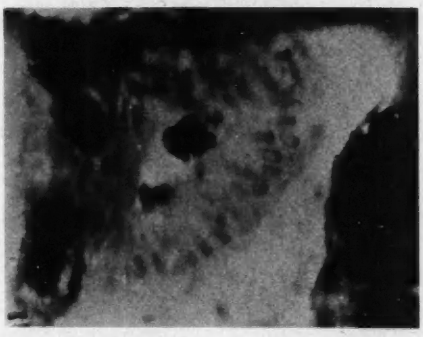

Fig. 1. Calcification in a dilated portion of the proximal convoluted tubules.

stone. Not all of them can be located and removed, particularly when small.

Careful examination of all nephrectomy specimens has been made to locate small calcifications in the hope that by such information clean operative removal of small stone fragments might be made easier. One result of such study of specimens has been the discovery of three cases in which more or less

extensive stone formation had taken place within the tubules in some portion of the kidney. In two of these cases the indications for operation were not stone. In the other a large pelvic stone was found which blocked off the upper calix of the kidney to form a hydrocalix. This dilated calix contained sand and the tubules of the kidney substance draining into that calix showed extensive calcification. In but one of the cases did the plate taken at the time of operation show density to indicate the calcification within the tubules. It is my practice to use the X-ray by the method of Sossman and Quinby on all kidneys

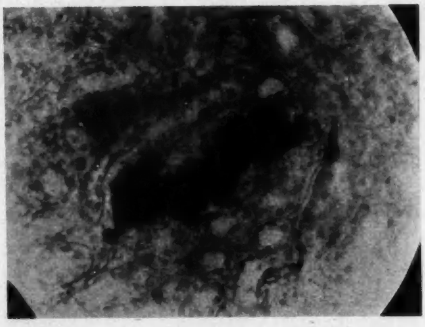

Fig. 2. Calcification in the distal convoluted tubules.

which are exposed at operation and are to be left in. Occasionally by this means stone has been found which did not show in routine cystoscopic and X-ray study previous to operation. Although such X-ray was done in the other two cases, it did not demonstrate the calcifications.

In all three instances in which tubule calcification has been found, there has been some form of obstruction to drainage either from the kidney pelvis as a whole as in one case with pelvic dilatation due to ureteropelvic junction obstruction by aberrant artery, to obstruction of a calix by calculus as has already been mentioned, or to local obstruction of a portion of the kidney by fibrosis. In all instances the tubules which contained the calcification as well as others near by showed dilata-

tion. I believe dilatation to be a requisite of such formation of calcification within the tubules. That the calcifications may pass from the tubules into the pelvis seemed to have been demonstrated by the presence of sand in the one case mentioned.

Infection was present in all three cases mentioned. It was bacillary in type; the colon bacillus was the organism found in each case.

It was not possible to recover sufficient of the calcified material from the calcified areas for chemical analysis. In the

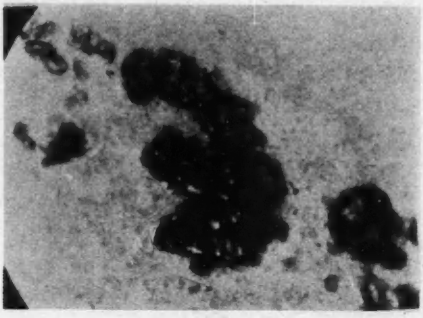

Fig. 3. Large masses of calcification in dilated tubules of the cortex.

instance in which sand was recovered from the pelvis, this showed oxalate stone. The crystallization seemed similar to that in the tubules and can be presumed to be of similar chemical nature.

The frequency of occurrence of tubule stone where more than the usual effort had been made to detect it shows that the condition is not an extreme rarity. It was found in three of the thirty-six nephrectomies performed in the Beth Israel Hospital in the first year and a half of its existence. Nineteen nephrectomies were for stone. Yet Jolly in his excellent recent book on renal stone does not mention it. Occasionally in the literature it is noted in passing as in a recent publication by Sanford. It is not to be confused with the uric acid infarcts of infancy, a transitory condition of no great clinical significance.

Its significance seems more comparable to similar calcification in the prostatic gland as reported to this society recently by Kretschmer.

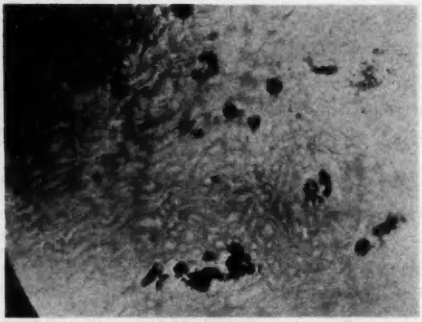

Fig. 4. Calcification in the efferent tubules of a pyramid. Note irregularity of size of lumens of these tubules.

The clinical significance of the condition can be considered to rest in two considerations: (1) If sufficient to show in

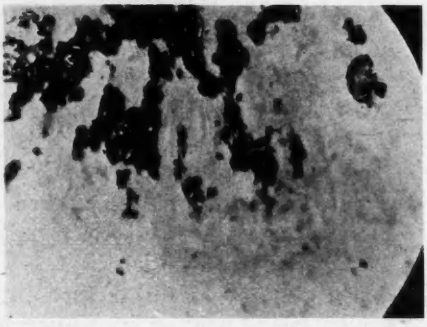

Fig. 5. Large masses of tubule calcification in the pyramidal portion of the kidney.

X-ray films of the kidney taken in the operation wound, it may lead to unprofitable attempts at removal with unnecessary traumatism to the kidney; (2) with removal of stones from

the pelvis, thereby establishing more adequate drainage to the tubules, these calcifications may then pass into the pelvis, where if drainage is incomplete they may not all pass, some remaining to serve as a basis for recurrent stone. That such passage into the plevis may take place seems established in one of the three cases here noted.

We have no evidence that such areas of tubule calcification take place in the comparatively normal kidney, since these are not removed and subjected to study. Yet none of these cases are reported from autopsy cases. It therefore is to be considered that they occur in pathological conditions in which tubule dilatation occurs as an end-result of obstruction of drainage from a part or the whole of the pelvis. If they play a part in the formation of pelvic calculi, it is in formation of satellite stone or to serve as the basis for recurrent stone formation.

DISCUSSION

Dr. Harry A. Fowler (Washington, D. C.): I have been very much interested in Dr. Braasch's paper and the slides which show so clearly the anomalous rotation of the renal pelvis. We have observed this condition in a number of cases which we picked up accidentally in the course of a routine pyelographic study.

Dr. Braasch did not read all of his paper, and therefore we did not understand from him whether there were any predominant clinical symptoms associated with this particular anomaly. Of course, there was some condition present which prompted the taking of the pyelogram, and I wondered what the condition was clinically that was the cause of making the investigation and if there is any group of clinical symptoms associated with this particular renal anomaly.

Dr. Vincent J. O'Conor (Chicago): In regard to Dr. Crabtree's contribution on the question of formation of minute calculi in the renal tubules, which I think is a very interesting contribution, the first time it was called to my attention was when studying some of Dr. Bauer's sections in Vienna three years ago. I think it was Lichtenstern who had reported some seventeen cases in which the kidney had been removed and in which the tubules were filled with calculi, but where the X-ray showed no gross stone formation.

Recently I had a patient in whom there was profuse bleeding from the left kidney over a period of some twelve months, following physical strain. There was a question of liability from an industrial point of view. The function of the kidney tested six times showed a marked diminution as regards the output of solids and also the output of dye.

The indications for surgery were rather obscure, except that the patient kept coming back with profuse hematuria from the left kidney, and very severe pain. The pyelogram was normal and numerous X-rays showed no stone formation.

About a month ago this patient filled his pelvis with blood

clot and came in demanding relief. I removed the kidney. At operation the kidney looked so normal that I hesitated to remove it, but in view of the fact that he had had such repeated localizing symptoms I removed it. On section the kidney, pelvis and calices were lined with sand—very fine grit. Microscopically the tubules showed very much the same thing that Dr. Crabtree has shown here, through very large portions of the kidney, with the exception that they seemed smaller than the ones he showed here.

I think the question of microlithiasis, that is, small stone formation in the tubules, in the presence of repeated attacks of renal colic and marked hematuria, must be borne in mind. I do not know that it occurs so frequently as we would believe from the studies in Vienna, but I think this is a very interesting contribution.

PROFESSOR A. VON LICHTENBERG (Berlin, Germany): I wish to compliment Dr. Braasch for his delicate diagnostic ability in going into this territory in which there are great advantages to be obtained. The morphologic importance of the pyelographic interpretation can do a great deal in diagnosis in this subject. The turning of the kidney can be judged from a morphologic and from a pathologic and embryologic standpoint, but it is very difficult to judge in all cases exactly which one of these factors is the cause of the condition.

It is important, concerning the operative indications, whether the condition is embryological or whether the condition is due to tumor formation.

It is indeed a point to be considered that in twenty-five years' experience with pyelograms, there is still to be developed a method by which one can visualize the kidney in its various rotating axes. One takes a kidney postoperatively, fills it and takes X-rays in the various axes to determine condition.

Concerning these kidneys that abnormally turn, I have found that there usually is an abnormal vessel condition in the upper pole or in the lower pole, that is, an embryological lobulation one wishes to replace the kidney in its normal position, there is nowhere for the kidney to be placed.

Vessel anomalies which cause the kidney to turn around also affect its replacement in its normal position. The investigation of only one factor will not indicate the entire solution. There are usually other factors, and the correction of only the embryological condition will not solve the problem alone. The other factors must be thoroughly investigated, as well.

DR. WILLIAM C. QUINBY (Boston): The subject which Dr. Crabtree has discussed interests me a great deal, for I have encountered it frequently in work on the experimental transplantation of kidneys. This same condition which Dr. Crabtree has found clinically, namely the deposition of lime in various tubular areas of the kidney, I found to be present always in those animals from whose kidneys the vascular supply had been shut off too long. In other words, I found these areas of calcification appearing in the earlier part of the work before I had acquired a sufficiently good technic to make the vascular sutures quickly. The phenomenon is very striking, and naturally, since this experience in animals, I have looked for similar cases in man. I have found only one clinical instance in which I feel that the same condition probably obtained. In that case, in the specimen removed at nephrectomy areas of lime were found deposited in the tubular portions of the kidney. Not only this, but the whole parenchyma had been very considerably destroyed by the process of lime deposit, and the pelvis obstructed so that there was present a considerable degree of hydronephrosis. The dilated pelvis contained innumerable very small bits of oxalate stone, so finely divided that from the first X-ray film of the kidney the only conclusion that could be drawn was that at a previous operation a gauze sponge had been left behind, which had had lime deposited in it.

Upon examination of the pathological specimen the conditions found were quite similar to those which Dr. Crabtree mentions.

I feel that the origin of such lime deposits is to be found in a primary local necrosis due to lack of blood supply, in which of the kidney. Then at the conclusion of the operation when areas the calcium deposit is a secondary phenomenon.

In the material submitted by Dr. Crabtree the primary cause for the necrosis in the walls of the tubules is to be sought, therefore, in lesions of their blood vessels. I think that the deposit of lime salts has no relation to the fact that we have in these instances to do with an organ having intimate relation to the urine; for one sees calcium deposits with moderate frequency in other bodily tissues, as for instance in a healed pulmonary infarct.

Dr. William F. Braasch (Rochester, Minn.): In response to Dr. Fowler's question, I would say that I was so interested in the anatomical phase of the subject that I quite forgot the clinical side. Patients with this condition come because of lateral abdominal pain, and in the course of determining its cause we find these anomalies. Of course, quite frequently we do not know whether the pain is being caused by this anomaly or not. When the anomaly is found to be present, however, and particularly if there is evidence of pyelectasis, we are warranted in making surgical exploration.

I am sure Dr. Hunt will agree that patients with anomalous renal rotation are observed with or without coincident sacculation or other deformity of the pelvis where on exploration no evidence of obstruction nor other evidence of gross pathology can be found, and changing the position of the kidney or freeing it from any adhesions very frequently will stop the pain.

In other words, there must be some factor, such as pressure on the renal pedicle or slight urinary stasis as the result of relation of the kidney to the surrounding structures, which at times causes the pain.

Dr. Fowler: Did you say general or local abdominal pain?

Dr. Braasch: Local abdominal pain, usually lumbar, although it may be anterior.

I certainly wish to thank Professor von Lichtenberg for his very generous discussion. In my text I went very carefully into the differentiation of some of the phases that he mentioned. One can usually differentiate congenital anomaly from torsion by the fact that the latter never has the characteristics of the embryonic pelvis, which the other always has. The influence of

the blood vessels upon rotation is of much interest, as Professor von Lichtenberg emphasized.

DR. HERMON C. BUMPUS (Rochester, Minn.): I had hoped Dr. Kretschmer would say something about the longitudinal division of the kidney pelvis. Would you feel that I was justified in believing that it is a longitudinal division, or is it a supernumerary kidney?

DR. HERMAN L. KRETSCHMER (Chicago): I thought it was a longitudinal division rather than a supernumerary kidney.

ENUCLEABLE MULTILOCULAR ABSCESS (CARBUNCLE) OF THE KIDNEY

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University, Virginia

Two cases have, in large measure, furnished the basis for the above title. Their records will be used as an introduction to a brief discussion of the treatment of a relatively uncommon renal condition.

Case 1.—A man of 24 years, admitted to the Surgical Service of the University of Virginia Hospital May 19, 1923, had had diffuse abdominal pain, malaise and fever for six days. Significant physical findings were lacking. During three days' observation, his temperature ranged between 103° and 106°, pulse around 90, leukocytes were 6,000, urine showed a few pus cells. He was then transferred to the Medical Service with a tentative diagnosis of typhoid fever.

There repeated blood cultures, stool cultures and serological tests did not reveal a typhoid or paratyphoid infection. He slowly developed localized discomfort and tenderness in the right flank, ultimately presenting, just below the rib margin, a rounded mass moving with respiration. Coincidentally, the temperature chart exhibited a septic curve, the leukocyte count mounted to 17,000. On June 25 he was transferred to the Urological Service.

Both kidney urines were pus-free, cultures negative. Thirty minute phthalein output after intravenous injection was 16 per cent on the right, 12 per cent on the left, no bladder leakage. Right pyelogram was normal but the renal shadow was abnormally large.

A working diagnosis was made of renal abscess or perinephritic abscess, or both.

At operation, June 27, the posterior perirenal tissues were soft, the kidney itself about twice normal size, intensely congested. As it was being freed intracapsularly, pus pockets were entered in a prominent area on the anterior surface of the middle third. By mere chance, my finger found a line of cleavage about a localized suppurative mass and readily enucleated it. The resulting depression had a diameter of about 5 cm., a depth of 2 cm. Its wall was smooth and appeared healthy. Save for the marked congestion, the remainder of the kidney seemed normal. A 2 ounce perinephritic abscess medial to the kidney had evidently followed erosion of the

capsule overlying the conglomerate renal abscess. Thorough drainage was established and the wound loosely closed. Straphylococcus aureus was grown from the pus. (A later account was secured of a few boils antedating onset of illness by a month.)

Pathological Report (Dr. W. E. Bray).—"Specimen is an irregular mass 6x4x2 cm., rather firm, containing many small gray abscesses and a few large ones. Microscopic sections show kidney tissue with degenerated tubular epithelium. The tubules are separated by rather large amounts of young fibrous tissue in which are many deeply staining round cells and plasma cells, as well as polymorphonuclears. Here and there are miliary and larger abscesses with areas of necrosis. Some abscesses have considerable fibrous tissue in their walls. There is some necrosis near the edge of one section, but this does not suggest an infarct."

Diagnosis.—"Acute purulent inflammation with abscesses; chronic inflammation."

The patient was discharged well thirty-seven days after operation.

Case 2.—Man of 29 years, admitted August 27, 1924, had suffered from recurrent, severe, left renal colic for seventeen days, afebrile for the first twelve days, thereafter with chills and fever. I first saw him September 1. Temperature then was 104°, leukocytes 13,000, the urine pus-laden. There was slight tenderness in the left flank, no induration. He presented an extensive Vincent's gingivitis, a sternal periostitis, an effusion in the left knee, a positive blood culture (staphylococcus aureus). Urinary tract films were negative. Cystoscopic investigation had shown the left urine very purulent, the right clear, the left fifteen minute phthalein output 0, the right 8 per cent. Ureteral catheter drainage of the left pelvis had been established.

The sternal infection went on to a frank staphylococcus osteomyelitis, resulting ultimately in the loss of two-thirds of this bone. The gingivitis was controlled after three weeks of vigorous treatment. Blood cultures were positive through September 6.

Cystoscopic findings September 19 were as before, both kidney cultures positive (staphylococcus aureus). There was slight pain and tenderness in the left flank, no induration.

A small stone was found in the bladder September 29. This had no doubt come from the left ureter though neither X-ray examination nor repeated ureteral catheterization had suggested its presence. The left urine still contained much pus but phthalein output (fifteen minute intravenous) had risen to 6 per cent against 11 per cent on the right. Save for slight fuzziness of outline, the left pyelogram appeared normal.

On October 4 abscesses of the prostate and soft tissues over the left shoulder were drained.

By October 10 there was induration both in the left costo-vertebral angle and deep-seated in front below the kidney region. Temperature continued to have a daily maximum of 102° to 103°. The kidney was explored that date with a working diagnosis of pyelonephritis and perinephritic abscess.

The perinephritic tissues were very thick and edematous. About 5 ounces of pus were evacuated from an abscess below the lower pole. The true renal capsule was exposed, opened and gently separated from the kidney. On the anterior surface of the upper one-third a group of abscesses was thus demonstrated. Since the feel and appearance here called to mind the previous case, a line of cleavage was sought and found. A septic mass approximately 5 to 6 cm. in diameter was readily enucleated. It had a clean-cut line of demarcation from the surrounding kidney and seemed to have a very definite capsule. While the kidney was large and very hyperemic, neither palpation nor inspection gave evidence of other abscesses. The kidney, therefore, was not removed.

Pathological Report (Dr. W. E. Bray).—"Carbuncle-like mass measuring about 5.5x3.5x3.5 cm., surrounded, save where ruptured, by a thin glistening capsule. Cross-section shows discrete abscesses of varying size, all containing thick greenish-yellow pus. Microscopic sections show acute suppurative inflammation of the kidney with multiple abscesses. One edge of the section is smooth and covered chiefly with fibrin and blood, along with some purulent exudate. No definite old fibrous capsule is made out, but there is an incomplete peripheral layer of young granulation tissue (early stage of encapsulation)."

His general condition promptly improved markedly. The daily temperature maximum shortly dropped to 100°. Seventeen days after operation the left kidney urine was grossly clear, sediment showed six to eight pus cells to the high power field, culture was still positive. Phthalein output was 11 per cent on the right, 6 per cent on the left.

Three days later, October 30, his temperature suddenly jumped to 104° and remained at that level. Careful overhauling revealed no new development to account for the change. It was decided that further suppuration in the left kidney was the most probable cause. For this reason, a rapid nephrectomy was done, November 3.

Pathological Report (Dr. W. E. Bray).—"The kidney measures 15x6 cm. The surface is smooth except near the upper and middle thirds, where there is a depression at the site of the former operation. The kidney is firm and the cut surface is apparently normal except for a few small yellowish opaque areas suggesting fatty degeneration."

Microscopic.—"One section shows almost complete loss of normal

structure, being chiefly inflammatory tissue with edema, hemorrhage, and cellular infiltration. Another section shows dilated tubules with degenerated and desquamated epithelium and a number of hyalin casts, also purulent exudate in a few tubules. The section through base of operative depression shows hemorrhage, edema and infiltration with round cell, p.m.n.'s and a few giant cells. There is considerable young fibrous tissue superficially and hyalinization of deeper fibrous tissue."

Diagnosis.—"Slight acute and marked chronic pyelonephritis with healed microscopic abscesses. (Because of the appearance of the subsiding inflammatory process, I would not expect the kidney to account for any marked febrile state.)"

Shortly after nephrectomy a right pneumonia was demonstrated, this followed by a streptococcus empyema. Death occurred November 8. An autopsy was not permitted.

The localized inflammatory process above described obviously warrants the title multilocular abscess and, further I think, fulfills all the requirements of the lesion first called renal carbuncle by Israel in 1891. Objection is raised from time to time to applying the term carbuncle to the kidney on the ground of definitional incompatibility or of adding further complexity to the classification of renal infections. While there is sound logic in this, the vivid descriptive value of the word, together with the sanction of increasing international usage, has doubtless secured for it a permanent place in medical terminology. It must be remembered, however, that the renal carbuncle of many writers is the infarct, septic infarct, multiple abscess, conglomerate abscess, or abscess of others.

The carbuncle in Israel's first patient was so sharply defined in color and consistency from the surrounding uninvolved kidney tissue as to give the impression of an imbedded tumor. Subsequent writers have often emphasized similar striking demarcation by verbal description and sometimes by accompanying illustration (Horn, Reschke, Barth, Nicholich, Hotchkiss). In Fisher's case the carbuncle was actually sequestrated. Barth and Smirnow in particular refer to the rich increase of connective tissue found about the pus pockets. An occasional illustration (Dick) suggests a thick fibrous tissue layer encircling the whole mass.

Other authors speak of the carbuncle shading off imperceptibly into the adjacent renal tissue. Frequently the carbuncle bulges above the cortical surface and has developed more at the expense of the cortex than the medulla. It may, however, be quite deep-seated and of an extent to cause demonstrable compression of a calix or calices, even of the pelvic body. Infrequently there may be two lesions in the same kidney (Smirnow, Eisendrath).

The carbuncle now and then is reported as having broken down to practically a single abscess cavity. It has not always been clear to me how cases found in the abscess stage and cured by drainage have justified report as carbuncles. Smirnow concludes that renal carbuncle has no tendency to such breaking down and will not accept as carbuncles large solitary abscesses so reported. I would deem it perfectly possible for a renal carbuncle to soften down to a solitary abscess but, so found, the evolution hard to prove.

In a series of fifty-seven cases collected from the literature, the following final methods of treatment have been employed: primary nephrectomy twenty-eight times with two deaths, incision and drainage eleven times with two deaths, secondary nephrectomy eight times with one death, primary excision six times with no deaths, secondary excision twice with no deaths and enucleation twice with no deaths. The nephrectomies totaled thirty-six with three deaths, other operations twenty-one with two deaths.

The figures indicate the decided necessity of, or preference for, nephrectomy as the surest and safest form of treatment. The extent of the process in many of the cases so handled clearly would have made a less radical procedure foolhardy. The illness of the patient sometimes has led to removal of the kidney even though the carbuncle seemed resectible (Barth). One would certainly expect nephrectomy to secure the smoothest convalescence, particularly if there is no complicating perinephritic abscess. Even the strongest advocates of primary conservative operations state that a later nephrectomy may be required.

Israel considers resection to be peculiarly suitable and feasible

for renal carbuncle. He mentions the potential danger of thus leaving unrecognized foci but believes such may well be taken care of by the body once the chief suppurative lesion is removed. Reschke successfully utilized excision three times and is a forceful advocate of conservative surgery for the condition. One of his excision patients developed an abscess in the same kidney during convalescence but this was readily drained through the original wound. Barth employed excision once with a good result and expresses the belief that he could readily have done so again in place of a nephrectomy. Nicholich voices a similar feeling in discussing the sharp demarcation of the carbuncle in a removed kidney. Successful resections are recorded by Lennander, Blum (cited by Israel), von Herczel (cited by Voss). Most writers mention resection as a possibility where the carbuncle is small, early, or sharply delimited, but actually the method seems to have been used quite infrequently. Where employed, incisions have been carried into the surrounding healthy tissue and the carbuncle extirpated in one or more pieces.

The only cases I found handled by enucleation are two reported as having infarcts by Hotchkiss in 1913. In the first, in addition to a perirenal abscess and an abscess of the upper pole, "there was found also a considerable triangular area of soft, white infarction, apparently riddled with small abscesses, and measuring about 2 inches across its base and not extending into the pelvis . . . infarcted portion readily enucleable with finger, . . . was neatly extirpated in this manner . . . the walls of the triangular gap in the kidney looked to be covered with granulations." Recovery followed. His second case showed a small perinephritic abscess. "There was a good sized white infarct in the upper pole of the organ, which was riddled with small abscesses. Having in mind my former experience, and as the rest of the organ appeared uninvolved, the whole area including the infarct was easily enucleated with the finger and without any considerable bleeding as the wall of the gap in the kidney appeared to be granulating, and healthy. Two catgut sutures were introduced, bringing the sides of the gap loosely together." This patient also recovered.

The enucleation in my first case was entirely unpremeditated and followed upon my finger finding an unexpected line of cleavage as the extent of the carbuncle was being explored. In both cases the enucleation was as easy as is the shelling out of a fibromyoma from the uterus. The second specimen grossly had a very definite glistening white capsule. Such was not observed for the first case, though the demarcation from the surrounding renal tissues was equally sharp in both instances.

I am convinced the secondary nephrectomy in Case 2 was quite unnecessary. The gross and microscopical appearance of the kidney suggested that it was recovering well from the unusual combination of an obstructive pyelonephritis and a carbuncle. The wisdom of having done a nephrectomy shortly after admission is another question but not pertinent to the topic under discussion.

Conservative surgery for renal carbuncle gains considerable support from an analysis of the twenty-one cases so treated—removal, ten, incision and drainage, eleven—in the series of fifty-seven reviewed. No secondary nephrectomies were necessary. Autopsies on the two patients who died, four days and twenty-four hours, respectively, after drainage of a carbuncle, revealed thrombosis of the iliacs and vena cava in one and an unsuspected carbuncle in the second kidney in the other.

The rare occurrence of bilateral involvement must be kept in mind in deciding upon the operative procedure for a given patient. Kretschmer has reported one such case, Smirnow cites two (Stuckey, Rjasanzewa). Reschke recounts the autopsy demonstration of a carbuncle in one kidney and an abscess in the other. The problem for the surgeon is much simpler, confronted later with a suppurative lesion in the second kidney, if the original carbuncle has permitted handling by some method less radical than nephrectomy.

I have no means of estimating how often enucleation will be possible for renal carbuncle. I feel it will occasionally prove a practical method where an excision or, more particularly, a nephrectomy might otherwise be done. The paucity of reference

to the procedure in the literature has seemed to justify giving it some attention. Certainly, when feasible, it is ideally conservative.

BIBLIOGRAPHY

BARTH: Der Nierenkarbunkel. Arch. f. klin. Chir., 1920, CXIV, 476.

COLMERS, F.: Ueber Nierenkarbunkel in Anschluss an eine Beobachtung bei einem Kinde. Ztschr. f. Urol. Chir., 1923-24, XIV, 235.

DICK, B. M.: Staphylococcal Suppurative Nephritis (Carbuncle of Kidney). Brit. J. Surg., 1928, XVI, 106.

EISENDRATH and ROLNICK: Urology. Lippincott, 1928.

FISCHER, H.: Septic Infection of Kidney after Infection of Finger. Ann. Surg., 1917, LXVI, 247.

HORN, W.: Ueber Nierenkarbunkel. Ztschr. f. Urol. Chir., 1923-24, XIV, 1.

HOTCHKISS, L. W.: On excision of the infarct in acute hematogenous infections of the kidney. Ann. Surg., 1913, LVIII, 226.

ISRAEL, J. and W.: Chirugie der Niere und Des Harnleiters. Georg Thieme, 1925.

KRETSCHMER, H. L.: Carbuncle of the Kidney. J. Urol., 1922, VIII, 137.

LAZARUS, J. A.: Two Cases of Carbuncle of the Kidney. J. Urol., 1929, XXI, 353.

LENNANDER, K. G.: Mitt. a. d. Grenzgeb. D. Med u. Chir., 1902, X, 164.

MATHÉ, C. P.: Carbuncle of the Kidney. Calif. & West. Med., 1924, XXII, 601.

MOORE, T. D.: Carbuncle of Kidney. South. M. J., 1929, XXII, 338.

NICHOLICH, G.: Diagnose und Therapic des Nierenkarbunkels. Ztschr. f. Urol., 1927, XXI, 564.

RESCHKE, K.: Ueber Paranephritis und Nierenkarbunkel. Arch. f. klin. Chir., 1924, CXXIX, 303.

SMIRNOW, A. W.: Ueber Nierenkarbunkel. Ztschr. f. Urol. Chir., 1926, XX, 243.

THOMPSON, T.: Case of Carbuncle of Kidney. Lancet, Lond., 1927, II, 695.

VOSS, R.: Ueber Nierenkarbunkel. Ztschr. f. Urol., 1927, XXI, 101.

CHRONIC GONORRHEAL PYONEPHROSIS AND URETERITIS

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The literature contains many contributions concerning the clinical aspects of gonococcal infections of the upper urinary tract and each contribution adds one or more instances presumably of this infection. The evidence presented for this diagnosis is totally inadequate in many instances and only presumptive in as many others. To be sure, there are several reports made of definitely proven cases, some of which present the local pathology in careful detail. This number, however, is relatively so small that the addition of a further case would seem to be justifiable.

At the present time the criteria for proving the diagnosis of gonococcal infection of the kidney consists of the appearance in the urine collected from the kidney, or from the exudate directly from the kidney pelvis, of properly staining cocci which grow only on special culture medium, presenting a typical colony formation, ferment only dextrose of the various sugar mediums, and give special immunological reactions. Where pathological tissue is available this diagnosis can be further strengthened by the presence of certain outstanding histological structures.

With these facts under consideration we wish to present the findings which resulted in making the diagnosis of chronic gonococcal pyonephrosis and ureteritis.

K. V., male, age 19, single, sought medical care, July 20, 1928, because of a persistently cloudy urine. He had been told three years before that his urine contained pus. The only subjective symptom was an occasional slight burning sensation during urination. About four months before July, 1928, the cloudiness of the urine increased and a mucoid urethral discharge was noticed. His family physician diagnosed gonorrhea. With gluteal injections and urethral irrigations the urethral discharge stopped within two weeks but the cloudy urine persisted. All gonorrheal treatment was stopped about two months before the patient came to us. During

these two months he had been at work daily. There was no frequency of urination or hematuria. He was well-nourished and apparently not seriously ill. He was without fever. A general examination failed to demonstrate gross disease; the abdomen contained no palpable masses and there was no tenderness over either kidney. The external meatus of the penis was small but no secretions could be expressed from the urethra. The scrotum and testes were unchanged. The prostate and seminal vesicle secretions were normal microscopically on repeated examinations and these organs were normal to palpation. The urine was turbid, amber, alkaline in reaction, having a specific gravity of 1.024, and containing 20 milligrams of albumin per 100 c.c., but no sugar. In the urine sediment were many leukocytes and bacteria. The blood contained 3,760,000 red cells, 9,700 leukocytes per cubic millimeter, the hemoglobin was

Fig. 1. Plain roentgenogram, revealing catheter curled up in large dilated left ureter.

Fig. 2. Incompletely filled pyeloureterogram indicating large tortuous ureter and less definitely dilated pelvis.

76 per cent, and the coagulation time five minutes and thirty seconds. In stained preparations of the blood there were no changes of the red blood cells, and the leukocytes were distributed as follows: neutrophil leukocytes 7 per cent, eosinphil leukocytes 1 per cent, transitional cells 1 per cent, large lymphocytes 3 per cent, and small lymphocytes 24 per cent. The Wassermann and Kahn reactions of the blood serum were reported "negative," the gonorrheal

complement fixation test "100 per cent positive." There were 12.7 milligrams of urea nitrogen per 100 cubic centimeters of blood.

A cystoscopic examination was made August 1, 1928. The external meatus of the penis was small, but after a meatotomy a No. 24F cystoscope passed readily and 8 ounces of turbid urine were collected from the bladder. The bladder capacity and tolerance were good. There was a moderate hyperemia of the entire bladder mucosa with a definitely increased hyperemia around the right ureteral orifice. The lips of the left ureteral orifice were puckered and deeply retracted into the bladder. Catheterization of the left ureter was impossible with a No. 4F. catheter because of an obstruction at its orifice. After a styleted No. 4F catheter had passed this obstruction, which extended upward from the orifice for 2 to 3 centimeters, urine escaped in regular drops. Two ounces of purulent urine were withdrawn from the left kidney by suction. The right ureter was catheterized readily with a No. 6F catheter and clear amber urine was collected in a normal flow. Phenolsulphonephthalein given intravenously appeared in excellent concentration in the urine from the right kidney within five minutes, but no trace of the dye appeared in the urine from the left kidney during twenty minutes. Fifty cubic centimeters of Cunningham's solution were injected for a left ureteropyelogram. The roentgen pictures demonstrated a marked left hydroureter and less precisely a marked dilatation of the renal pelvis (Figs. 1 and 2). It is readily seen that the left catheter was looped and extended upward to the mid-portion of the sacrum. The left ureter was greatly dilated throughout its well visualized lower half. The kidneys could not be outlined definitely. The outlines of the dilated kidney pelvis and calices were indistinct and irregular, suggesting extensive destruction of kidney tissue.

At this time the nature of the kidney infection was not suspected but when the sediment of the urine from the bladder and from the left kidney, stained according to the Gram method, was examined, many gram-negative diplococci, most of them within phagocytes, were found. Acid-fast bacilli were not found. Other samples of urine, later, were brought directly to the laboratory and cultured on blood agar. After seventy-two hours a few colonies of gram-negative diplococci were found in the cultures of urine from the bladder and from the left kidney, while the urine from the right kidney was normal microscopically and produced no growth on serum mediums.

The organism was obtained in pure culture twice in urine from the left kidney, but in cultures of the bladder urine an organism resembling B. crassus was associated.

Operation.—The diagnosis was made of chronic pyoureteronephrosis, probably gonococcal, and accordingly the left kidney and entire ureter were removed August 9, 1928, and the mucoid almost

transparent secretion containing only a few leukocytes obtained from the renal pelvis was cultured at once on blood agar. Careful search in stained slide preparations demonstrated leukocytes with intracellular gram-negative diplococci and in the plate cultures within forty-eight hours there were many colonies of gram-negative diplococci. These colonies were gray, semi-transparent, faintly opaque, mucoid and became more opaque and had slightly irregular margins as they grew older. Well isolated colonies attained a maximum diameter of 2 to 3 mm. The organism in subcultures grew on plain blood agar with some difficulty, but more luxuriantly on similar mediums containing 0.1 per cent disodium hydrogen phosphate and 0.2 per cent sodium chloride. The organisms did not grow on plain nutrient agar.

The first attempts to study the fermentation reactions were unsuccessful because the organism failed to grow either aërobically or anaërobically in autoclaved placenta infusion broth containing 10 per cent human serum, in veal infusion broth with 10 per cent human serum, or in Huntoon's semisolid hormone medium with and without human serum. Finally growth was obtained in veal infusion broth containing 40 per cent human serum. A slight but distinctly acid reaction to bromcresol-purple was noted in mediums with dextrose after five to seven days' incubation, but no acid in mediums with mannite, maltose, levulose, or sucrose. After twelve days' incubation the organism was isolated in pure culture from each of the inoculated mediums. Since bromcresol-purple did not give a sharp color change, serum-broth mediums containing the various sugars but no indicator were incubated and at the end of seven days pH determinations were made colorimetrically with bromthymol-blue as indicator. The pH of the dextrose broth cultures was less than 6.4, that of the maltose, mannite, levulose, and sucrose was 7.4, the orginal reaction of the mediums and the same as the control tubes of mediums incubated but not inoculated.

A strong complement fixation test was obtained with serum from the patient with a gonococcus antigen prepared by Parke, Davis and Company. The serum from the patient, however, failed to agglutinate the organism isolated from the kidney. It seemed necessary, therefore, to prepare immune serums in rabbits (1) with the organism obtained from the patient, and (2) with a mixture of six of the thirteen strains used in preparing the gonococcus antigen and kindly furnished by Parke, Davis and Company. After several months' growth on artificial mediums the organism from the patient had lost some of its mucoid property and could be held in a relatively stable suspension in a 0.8 per cent sodium chloride solution. All of the suspensions were made in salt solution with nineteen to twenty-four hour cultures, and the coarse particles were removed by filtration through a thin layer of absorbent cotton.

The immune rabbit serum prepared with the organism isolated

from the kidney agglutinated the homologous organism in dilutions as high as 1:400 and three selected strains obtained from Parke, Davis and Company in dilutions of 1:100. This immune rabbit serum with the original gonococcus antigen gave a positive complement fixation test in dilutions containing only 0.0004 c.c. of the serum in 2 c.c. volume. The polyvalent immune rabbit serum pre-

Fig. 3. Photograph of kidney and ureter, noting marked destruction of renal tissue and dilatation of ureter.

pared with the organisms obtained from Parke, Davis and Company agglutinated the organisms from the kidney in 1:320 dilution and five homologous strains 1:40 to 1:400. The organisms of the sixth strain were not agglutinated by this homologous serum. Neither of these serums had any effect on M. intracellularis, M. catarrhalis, or M. subflavus. Direct and cross absorption experiments with the cross agglutinating strains demonstrated almost complete absorption of the agglutinins in both serums by the organism recov-

ered from the patient and three strains obtained from Parke, Davis and Company. The absorption of the agglutinins in each serum was slightly more where the homologous organisms were used.

Pathological report was made by Dr. Edwin F. Hirsch (Fig. 3), to whom we are greatly indebted for pathological studies and suggestions on bacteriological work. The left kidney, opened longitudinally along the convex margin, had a markedly dilated pelvis and widened calices so that the cortical and medullary substance ranged in width between 2 and 10 mm. The usual cortical markings were effaced and the pyramids were markedly truncated. The maximum circumference of the renal pelvis was 11 cm.; the lining

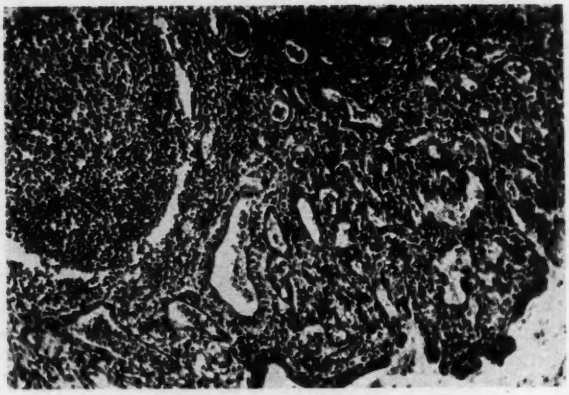

Fig. 4. Photomicrograph revealing discrete node of lymphoid tissue, associated with lymphocytes, plasma cells and eosinophil leukocytes of the mucosa and submucosa.

was smooth, gray-pink, mottled about 10 per cent with small hemorrhages. The mucosa was thickened to 1 mm. The capsule stripped with difficulty, leaving a finely granular surface mottled about 5 per cent with small hemorrhages. The attached ureter was markedly dilated. Its maximum inside circumference 12 cm. below the uretero-pelvic junction was 3.7 cm.; its maximum circumference 6 cm. below the pelvis was 2.5 cm. The lining of the ureter was smooth, gray, mottled about 10 per cent with petechial hemorrhages. The average thickness of the wall of the ureter was 2 mm. In histological preparations the epithelial lining of the ureter was regular, the submucosa a loose fibrous tissue with disseminated lymphocytes, plasma cells, eosinophil leukocytes and discrete nodes of lymphoid tissue. These inflammatory changes extended into the muscularis and other portions of the wall. The parenchyma of

the kidney was markedly altered by chronic inflammation and scar tissue so that in histological preparations (Fig. 4) there were only distorted tubules and scarred glomeruli. These were held in scar tissues with lymphocyte, plasma cell, and eosinophil leukocyte infiltrations. The changes in the mucosa of the renal pelvis were essentially like those in the ureter; large collections of lymphocytes, some in nodules as large as in lymph node tissues, were especially noteworthy. Into some of these tissues of the medulla near the pelvis there were dense infiltrations of leukocytes.

The patient made a satisfactory postoperative recovery and has had clear sparkling urine from the day of the operation.

The findings here presented, we believe, demonstrate the presence of a chronic pyonephrosis and ureteritis produced by the gonococcus as the primary and only exciting organism. The organisms were recovered, unaccompanied by other bacteria, both from the catheterized urine from the kidney as well as from the exudate adherent to the kidney pelvis. These organisms were essentially intracellular and complied morphologically with the appearance of the gonococcus, as well as being negative to the Gram stain. They grew only on mediums containing serum, and on plate cultures developed colonies typical of this organism. They fermented glucose, but not mannite, maltose, levulose or sucrose. The patient's serum gave a strongly positive complement fixation reaction, using a polyvalent gonococcus antigen. Special agglutinin and agglutinin absorption experiments likewise classified the infecting organism in the gonococcus group. The histopathology of the kidney and ureter corresponds with similarly studied material from proven cases.

Johnson and Hill[10] consider the appearance of the organism in a Gram stained smear from the material being studied together with its cultural characteristics as only presumptive evidence; definite positive differential identification must also include either the proper biochemical or the immunological reactions. This is in direct accord with the findings of Elser and Huntoon[7] that the gram-negative cocci in exudates all show a predilection for the interior of leukocytes and cannot be differentiated on morphology or grouping. They further find that the meningococcus, pseudo-meningococcus and gonococcus cannot be differentiated with certainty by an examination of the growth on ascitic agar plates. Strength is added to the Johnson and Hill standard of identification of the gonococcus by

the finding of the micrococcus catarrhalis in the kidney by Shivers,[18] the gonococcus in the meninges by Prochaska[17] and Lindenfeld[14] and the meningococcus in the seminal vesicles by Pick.[16]

Konrad and Parlow[11] in 1928 collected thirty-three cases of reported gonoccocal infections of the kidney from the literature with but five indisputably authentic cases, including one of their own. No doubt many of this entire number were true gonococcal infections, but the evidence presented is insufficient in a great majority of the cases according to our present standards. These standards eliminate from consideration all of the earlier cases, studied before anything was known about the biochemical and immunological features concerned in the differentiation of this organism.

Despite the enormous frequency of gonococcal infections of the lower urinary tract, infections of the kidneys themselves are extraordinarily rare. This is all the more remarkable when the facts are considered that the kidney is so frequently the object of metastatic and ascending infection by other organisms and that the blood stream quite commonly carries the gonococcus as evidenced by a relatively large number of other metastatic conditions such as arthritis and iritis.

The pronounced histopathology noted in our case was the presence of collections of lymphoid tissue in the submucosa of the ureter and renal pelvis resembling in many respects a true lymph follicle. These were striking observations made also by Zinner[21] and Barney,[1] the only other authors who give complete histologic findings. In all other respects the findings were not unlike any other chronically infected kidney associated with obstruction to its outlet.

The stricture formation of the lower 2 to 3 centimeters of the ureter was firm and resistant, which fact, when considered with the marked obstructive pathology above it, suggests its long standing. This patient was known to have a gonorrheal infection but four months before, but had a symptomless pyuria for three years. Certainly the local pathology was not produced within four months. Either one of two possibilities must be considered: (1) there was a pre-existing ureteral obstruction and hydronephrosis which became infected by the way of the ureteral orifice or through the blood stream or (2) the pyuria

of three years' standing was an expression of a gonococcal infection during that entire period. Dourmashkin and Cohen[5] observed a patient with a low ureteral stricture associated with an infected gonococcal hydronephrosis. They made no statements as to the pathogenesis of the conditions; while Zinner[21] in describing a case, in many respects resembling our own, believes the gonococcus entered the lower ureter either by reflux

CHART I.

CHARACTERISTICS OF THE STUDIED INFECTING ORGANISM

Source	Directly from the exudate of renal pelvis
Morphology and grouping	Intracellular and extracellular diplococci.
Staining	Gram-negative
Cultural	Do not grow on ordinary serum free medium. Serum plate colonies faintly opaque, mucoid, sharply defined borders early. Later—more opaque with irregular margins.
Biochemical	Ferments only dextrose
Immunological	(1) Homologous immune rabbit serum agglutinates the organism in 1:400 dilution Homologous immune rabbit serum agglutinates 3 gonococcal strains 1:100 Homologous immune rabbit serum with gonococcus antigen gives positive complement fixation reaction using 0:0004 c.c. of serum (2) Polyvalent immune rabbit serum agglutinates this organism in 1:320 dilution Polyvalent immune rabbit serum agglutinates 5 homologous strains 1:40 to 1:400 dilution Neither of these serums agglutinates meningococcus, catarrhalis or subflavus. Almost complete absorption of agglutinin from both serums by this organism and by a mixture of three strains of gonococci.

or by direct transference of the inflammatory process from the mucosa of the bladder to that of the ureter, and here set up an infection which resulted in stricture as it does in the urethra.

Repeated study of the genital tract of our patient failed to reveal any changes either on palpation of the prostrate and seminal vesicles or in the microscopic study of their secretions. This finding should have considerable bearing on this question, since it is quite generally understood that, in the male, gonococcemia occurs only through infected seminal vescles or prostate. In instances such as ours it seems more logical that the infection reached the ureter directly from the urethra by way

of the bladder. The pathogenesis of the lesions is more clearly understood from this viewpoint. First, an inflammation of the lower ureter resulting in stenosis and hydronephrosis which, of course, is infected from its beginning. All local factors are thus arranged for eventual complete destruction of the kidney.

Available reports would indicate that this type of infection can frequently be successfully managed by conservative measures such as pelvic lavage. Complete success was obtained in this manner by Lewis,[13] Hagner,[8] Lehr,[12] Wynne,[20] Hoover,[9] Young[19] and Dodge[4] while Bueger's[3] results with ureteral dilatation and pelvic lavage in the presence of low ureteral stricture and infection are of special interest.

Boyd's[2] patient was cured by the use of anti-meningococcic serum.

That an upper urinary tract infection, with the gonococcus, may be of more than scientific interest is well expressed in those instances where this secondary source may eventually act as a primary focus to reinfect repeatedly the lower genito-urinary tract. This possibility is clearly demonstrated by carefully observed cases of Lewis[13] and Wynne,[20] who independently present instances of intractable genital infections in males that were readily eliminated after ureteral catheter diagnosis of renal infection and subsequent pelvic lavage.

A prominent feature of the bacteriological findings is the relatively great number of mixed infections; about one-third of all cases reported were associated with the usually infecting pyogenic bacteria. The common surgical procedure has been nephrectomy. The pathology in these cases was due, for the most part, to ureteral obstruction or some renal anomaly, together with the specific infection. Thus Dozsa[6] found an obstructing renal vessel, Barney[1] an aplastic kidney, Nixon's,[15] Zinner's[21] and our own case inflammatory ureteral obstructions.

BIBLIOGRAPHY

1. Barney, J. D.: Gonococcal infection of the kidney. Jour. Urol., lx:79-86, 1923.
2. Boyd, M. L.: Gonorrheal ureteropyelitis. Surg., Gynec. & Obst., xxi:506-510, 1915.
3. Bueger, L.: Renal and ureteral infection with the gonococcus. New York Med. Jour., cviii:1022-1028, 1918.

4. DODGE, W. T.: Catheterization of the ureters. Jour. Mich. State Med. Soc., iv:58-62, 1905.
5. DOURMASHKIN, R. L., and COHEN, H.: Gonococcal infection of the kidney with spontaneous recovery; report of a case. Jour. A. M. A., lxxx:1052, 1923.
6. DOZSA: Ztschr. f. Urol. Leipz., xv:280, 1921.
7. ELSER, W. J., and HUNTOON, F. M.: Studies on meningitis. Jour. Med. Res., xx:373-541, 1909.
8. HAGNER, F. R.: Gonococcus infection of the kidney with report of cases. Med. Rec., N. Y., lxxiii:568-572, 1910.
9. HOOVER, F. B.: Gonorrheal renal infections. Interstate Med. Jour., St. Louis, xxii:163-167, 1915.
10. JOHNSON, F. P., and HILL, J. F.: Gonococcal infection of the kidney and criteria for its diagnosis. Jour. Urol., xl:177-178, 1928.
11. KONRAD, E. B., and PARLOW, A. L.: Gonococcal infection of the kidney. Jour. of Urol., xx:83-95, 1928.
12. LEHR, L. C.: Report of case of gonorrheal pyelitis. Jour. A. M. A., lix, 1912.
13. LEWIS, B.: Three ureters demonstrated during life; ureteral catheterizations giving three different urines, one infected with gonococci. Med. Rec. N. Y., lxx: 521-524, 1906.
14. LINDENFELD: Med. Klin., 18:176, 1922.
15. NIXON, P. J.: Gonococcal infections of the kidney. Surg., Gynec. and Obst., xii:331-341, 1911.
16. PICK, L.: Ueber Miningokokken, spermatocystitis. Berl. Klin. Wchnschr., xliv:947-953, 494-498, 1907.
17. PROCHASKA, A.: Bacteriologische Untersuchunger bei gonorrhorschen Allge Meninfektionen. Deut. Arch. f. klin. med., lxxxiii:184-96, 1905.
18. SHIVERS, C. H.: A possible mistake in the diagnosis of gonococcal infection of the kidney. Jour. A. M. A., lxxx:1359-1361, 1923.
19. YOUNG, H. H.: The gonococcus. A report of successful cultivations from cases of arthritis, subcutaneous abscess, acute and chronic cystitis, pyonephrosis and peritonitis. Johns Hopkins Reports, lx:677-707, 1900.
20. WYNNE, H. M. N.: Kidney infections due to the gonococcus. Journal Lancet, Minneapolis, xliii:352-354, 1923.
21. ZINNER, A.: Zur Kenntnis de Gonorrhoischen, Nieren infektionen Wein. Klin. Wochenschr., xxxix:1179-1180, 1926.

DISCUSSION

DR. J. BAYARD CLARK (New York): May I ask Dr. Culver if there was a history of a previous genital infection in his reported case?

DR. HARRY CULVER (Chicago): There was, four months before, and the patient was discharged as cured, but he had had the pyuria for three years, a condition which had not changed after the probable cure of the genital infection.

DR. ARTHUR L. CHUTE (Boston): In the only case of carbuncle of the kidney that has come under my care, I took the easy way and took out the whole kidney. I dare say Dr. Neff's way would have been better, but I did not dare take the responsibility of doing other than just taking the whole thing out.

As regards the gonococcal pyonephrosis, I have absolutely no knowledge whatever. It is very interesting, and Dr. Neff's numerous means of identifying it seem to be very interesting, too.

DR. GILBERT J. THOMAS (Minneapolis): I think Dr. Neff's report of the carbuncle of the kidney is tremendously important because it brings to our attention a pathological condition that is usually very difficult to handle, primarily because the diagnosis may be difficult and delayed. Carbuncle of the kidney is usually secondary to skin infections, although osteomyelitis is frequently an etiological factor.

Patients who have had a carbuncle or other infections of the skin may not have severe symptoms during the invasion of the kidney. They may not have chills with high fever, which is frequently reported. My associate, Dr. E. W. Exley, and I recently observed a patient who had a carbuncle of the skin which was followed in about two weeks with fever, which was not more than 100.5 or 101, but which continued, so that tentative diagnosis of tuberculosis of the lung was made by an internist.

Eventually pus appeared in the urine, so that the attention of the diagnostician was directed to the urinary tract, and we were consulted concerning the pyuria.

At this time the patient had not had pain in his flank. A day or so following the onset of the pyuria, aching pain was complained of in the side, so in this case, at least, it was very diffi-

cult when the patient was first seen to make a diagnosis of a renal infection or even to think of it.

We find lung complications to be frequent. When the infection gets outside the kidney in the perirenal tissue, lung infection may occur as a complication. In our last patient, we did find involvement of the lower portion of the lung on the same side where the carbuncle was found.

The first urological examination did not assist us in the diagnosis, because we found pus in both kidneys; in other words, the patient had at this time a bilateral pyelonephritis. A bilateral pyelogram did not assist the diagnosis. We obtained negative blood cultures from the patient.

The treatment of this interesting condition is sometimes just as difficult as the diagnosis. Eventually, the surgeon's attention is directed to the kidney and exploration is advised. Usually the surgeon finds a perinephritic infection with an abscess, which is drained, and there the treatment may stop. The postoperative course following drainage of a perinephritic abscess will indicate to the surgeon a continuation of the renal infection, so that a secondary nephrectomy must be done.

We find in making a secondary operation that the perinephritic tissue is so adherent that nephrectomy is very difficult and there is danger of rupturing into the peritoneum. Since the patient is non-resistant to staphylococcus, this would be very dangerous. Many other complications arise to make the operation difficult. In our recent experience, the pedicle could not be tied and a clamp had to be left in the wound.

We were able to enucleate one of the carbuncles from the kidney, but if we had stopped there, we would have missed two others in the same kidney. We had no indication when the kidney was explored externally that they might be present.

We have found that convalescence in this sort of condition is very long. The patient is very non-resistant to staphylococcic infection and will, when lying in bed, develop sores of the skin, etc.

We found, in searching the literature, that there is only one case reported where the condition was bilateral.

DR. E. GRANVILLE CRABTREE (Boston): I wish to mention one case of carbuncle of the kidney occurring in the eighth month of pregnancy in the Boston Lying-In Hospital, in which

the symptoms were fulminating, and no other source of infection was noted, in which the treatment was by local curettage, with recovery of the patient.

DR. FRANCIS R. HAGNER (Washington, D. C.): We had one interesting case in which a child had had tonsillitis and the urinary findings were practically negative. There was some tenderness over the kidney, however, and an exploratory incision was finally made and an abscess was found at the lower pole of the kidney. The rest of the kidney appeared normal. A V-shaped piece containing the abscess was removed and the child made a recovery.

DR. DAVID W. MACKENZIE (Montreal): In discussing the carbuncle of the kidney, I wish to mention a few cases and the points of differentiation that struck us at the time. The first case was that of a young man who had a definite carbuncle of the neck. There were no urinary symptoms. The tumor developed in the routine way, on one side. This patient had a nephrectomy done, and made an uneventful recovery.

At the time, the suggestion was made that the kidney might be saved but there was very little normal tissue.

The next one was a middle-aged man who had a definite carbuncle on one side and a pyelonephritis on both sides.

The third one, which is perhaps the most interesting of all, came to us having been drained on the right side elsewhere, pain developing on the left side. We operated and enucleated a carbuncle of the kidney. The patient went on for a while, and again trouble started on the right side that had already been drained. We went in and removed a large carbuncle in a badly infected kidney from this side, having enucleated a carbuncle from each kidney.

I want to bring up the question of cortical abscess of the kidney as opposed to carbuncle. As in Dr. Hagner's case, four cases came to our attention at the same time, developing following tonsillar abscesses, but none of those resembled carbuncle at all. They were definite multiple cortical abscesses of the kidney.

DR. GEORGE R. LIVERMORE (Memphis): I would like to ask Dr. Culver if ureteral catheters had been passed on his patient before he saw him.

DR. CULVER: No.

ACTINOMYCOSIS OF THE KIDNEY

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Renal actinomycosis in the past has been considered as primary when the disease was confined to the kidney, and secondary when other actinomycotic lesions were associated in other structures of the body. It is difficult to conceive of the kidney as the site of a primary infection, and it would seem that involvement of the kidney, in most instances, if not in all, must be secondary to a portal of entry through mucous membrane. The kidney may become involved by direct extension from the gastrointestinal tract in abdominal actinomycosis, through the diaphragm from pulmonary disease, or by metastasis through the lymphatics or blood stream.

In the case herein reported, as nearly as can be determined, the disease was confined entirely to the right kidney, as is evidenced by the patient's complete recovery after right nephrectomy. That the condition may have been secondary to actinomycosis of the appendix, however, must be given consideration, even though such infection was never proved in the appendix or intestinal tract, and even though there was no evidence that such infection ever had existed.

REPORT OF CASE

A man, aged 32 years, an accountant, previous to July, 1928, had had repeated attacks of pain in the right lower quadrant of the abdomen. In July, 1928, he was operated on elsewhere than at the clinic, and a ruptured, partially gangrenous appendix was removed. Drains were inserted for three weeks; then the wound was allowed to heal. In six weeks, apparently after an uneventful recovery, he left the hospital with only a slight amount of serous drainage. This subsided and he gained in strength.

September 10, 1928, what was apparently a stitch abscess developed and was drained. The wound was packed for one week and finally healed. September 27, the patient felt feverish, had night sweats, lost appetite, and pain developed in the right costovertebral angle. Examination revealed only a tender right kidney. The patient was hospitalized, symptoms continued, and vague distress developed in the right portion of the epigastrium. The urinary

tract was normal on laboratory and urologic examination. The condition grew worse. A mass, which seemed to be liver, became palpable and progressed downward; it was painful to pressure and movement. Chills, jaundice, or digestive disturbances other than a poor appetite were not present. There was less pain over the costovertebral space; the urine was clear; leukocytes numbered 16,000 in each cubic millimeter of blood. October 27, it was concluded that a retroperitoneal abscess was present. A small incision was made in the right upper quadrant of the abdomen, and after careful exploration only slight enlargement of the liver was found. The incision was closed without drainage and primary healing occurred.

February 25, 1929, a cold developed; the patient had a chill and ran an elevated temperature for ten days. He had another chill, following which he improved except for residual discomfort in the right kidney. April 4, the symptoms and signs of October, 1928, were exactly reproduced except that this time the amount of pus in the urine was increased.

May 16, 1929, the patient registered at The Mayo Clinic. He weighed 115 pounds, which, according to him, represented a loss of 25 pounds. His skin was tanned but he was anemic, graded 2, and his tongue was furred. He had moderate tenderness in the right costovertebral angle, and resistance in the right upper half of the abdomen.

May 16, 1929, the patient was placed in hospital, and ran a septic temperature varying between 102.5° and 97.3°F. In roentgenograms there was a large right renal shadow and absence of the outline of the psoas muscle. The opinion given was that probably a perinephritic abscess was present. The urine repeatedly contained pus, graded 3. Leukocytes numbered 13,000 in each cubic millimeter of blood. The hemoglobin was 30 per cent. In a test of renal function with phenolsulphonephthalein 80 per cent of the dye was returned. The Wassermann reaction of the blood was negative. The urea was 18 mg. in each 100 c.c. of blood. May 20, cystoscopic examination was performed. A right pyelogram showed that the pelvis was small, and that there were several small filling defects. The upper and lower calices were elongated and the middle calices were absent. The upper minor calix was dilated. The ureter was normal. The pyelogram suggested a right renal tumor, with marked decrease in function. The left kidney was normal in function.

May 24, right nephrectomy was done. The kidney was one and a half times normal size and was densely adherent as a result of an old perinephritic abscess, which, although large, had pretty well subsided. What appeared to be a carbuncle measured 8, 6 and 4 cm. in various diameters and involved the middle third of the renal substance. The pathologic report was: multiple confluent abscesses involving the cortex and medulla of the central portion of the kidney; so-called carbuncle of the kidney; marked perinephritis, with

old perinephritic abscess, and destruction of about 70 per cent of the renal substance.

July 3, nearly six weeks after operation, a diagnosis of actinomycosis was made through recovery of actinomyces from the wound. The wound, at this time, consisted of multiple deep sinuses, and in order to carry out adequate therapeutic measures for actinomycosis, the wound was widely opened to the bottom of all sinuses and was packed wide open with gauze. Intensive treatment with roentgen rays and with the use of radium in the depths of the wound was instituted. Iodids were given in the form of a 10 per cent solution of sodium iodid intravenously, and potassium iodid by mouth. The patient was dismissed December 2, 1929, with a practically completely healed wound and with return of normal weight and strength. It has not been possible, at any time, to find lesions elsewhere in the body which might be considered to be those of actinomycosis. Repeated roentgenologic examination of the thorax failed to reveal any evidence of pulmonary involvement.

Within two weeks we have had a report on the patient's condition. Complete healing of the wound has occurred, and the patient is entirely well.

COMMENT

If the original classification of actinomycosis of the kidney must be adhered to, this case may well be considered one of primary actinomycosis with recovery subsequent to nephrectomy. Israel was the first to report a case of primary renal actinomycosis. At the time the report was made, in 1901, the patient had remained well eleven years after nephrectomy. The same author in 1911 reported a second case, with recovery after nephrectomy. Since that time Stanton, Kunith, Kleinschmidt, Pinner, Bevan, Abbot, Peacock, Christison and Warwick, and Beregoff have each added one case. Von Lichtenberg stated in his "Handbuch der Urologie" that primary renal actinomycosis had been reported only seven times; Von Lichtenberg included, as did Abbot, a case reported by Theodore Cohn and one by Earl. Data available did not seem sufficient for us to include Cohn's case as one of true renal actinomycosis. Data in Earl's case are lacking beyond the statement that the patient was a male, aged 52 years, in whom a secondary actinomycotic abscess of the brain was found.

The case reported by Christison and Warwick can hardly be considered one of renal actinomycosis, for only the suprarenal gland was involved and that secondarily to pulmonary actinomycosis in which the infection had traversed the diaphragm.

The kidney is sometimes involved secondarily as a part of generalized actinomycosis. Von Lichtenberg stated that secondary actinomycosis of the kidney occurred in nine of 128 fatal cases of actinomycosis in which necropsy had been done, an incidence of 7 per cent. In all but one of these nine cases both kidneys were involved. Pinner stated that in 460 cases of actinomycosis of the thorax and abdomen there were sixteen in which the kidney was involved secondarily.

Objective and subjective data concerning the urinary tract and suggesting renal tumor or infection of the kidney in the presence of actinomycosis elsewhere, or history of preëxisting actinomycosis, perhaps should cause one to think of this type of renal involvement. Unless actinomyces are present in the urine, however, or in a postoperative sinus, there is little to suggest a preoperative diagnosis of renal actinomycosis. In the cases reported in the literature it is of interest that actinomyces were found in the urine of two patients (Pinner's and Beregoff's) and this led to the clinical diagnosis of renal actinomycosis. In several instances, the diagnosis was established through the finding of actinomyces in material from a sinus which persisted after drainage of a perinephritic abscess or which persisted subsequent to nephrectomy. In three cases, including our case, a preoperative diagnosis of renal tumor had been made.

In seven of the twelve cases in the literature, including our case, nephrectomy was done. Five patients recovered. The result in Kleinschmidt's case, in which nephrectomy was done, is not recorded. Death occurred on the twelfth day in Peacock's case in which nephrectomy had been done, and actinomycosis of the liver was found at necropsy.

The prognosis in actinomycosis in general is notoriously poor. Recovery from so-called primary renal actinomycosis, when the disease is confined to one kidney, may be expected only by means of nephrectomy and the institution of therapeutic measures such as those which are employed for actinomycosis in other situations. These measures were used in the case reported and are, in brief, the following: (1) maintaining the wound wide open to its most dependent parts; (2) packing the wound wide open, down to its lowest depth, with gauze saturated with dichloramine-T in 4 per cent solution, or with compound solution of iodin diluted to one-third to one-half strength; (3) introducing

*Apparently true cases of primary renal actinomycosis.

TABULATION

SUMMARY OF CASES OF RENAL ACTINOMYCOSIS FROM LITERATURE

Author	Age, years	Sex	Preoperative diagnosis or basis for diagnosis	Operation or necropsy	Observations at necropsy	Results
*Israel	33	M	Actinomyces from sinus	Nephrectomy		Recovery
*Israel	60	F	Perinephritis	Nephrectomy		Recovery
*Stanton	53	M	?	Necropsy	Actinomycosis confined to right kidney	Death
*Kunith	5	M	?	Nephrectomy		Recovery
Kleinschmidt	24	M	Renal tumor	Nephrectomy		Unknown
*Pinner	40	M	Actinomyces found in urine	Nephrectomy		Recovery
Bevan	?	M	?	Drainage		Unknown
Abbot	43	F	Renal tumor	Drainage	Perinephritic abscess; destruction of two vertebræ; multiple actinomycosis of lungs	Death in two months
Peacock	8	M	Renal tuberculosis	Nephrectomy	Actinomycosis of liver	Death
Christison and Warwick	8	M	?	Necropsy	Extensive actinomycosis of lungs and involvement of right suprarenal gland	Death
Beregoff	63	F	Actinomyces found in urine	Necropsy	Bilateral renal actinomycosis	Death
*Hunt	32	M	Renal tumor	Nephrectomy		Recovery

*Apparently true cases of primary renal actinomycosis.

radium into the wound as long as sulphur bodies are repeatedly found; (4) administering treatment by roentgen rays over the entire area, and (5) persisting in the use of iodids in the form of a 10 per cent solution of sodium iodid intravenously, or the oral administration of potassium iodid, or both.

BIBLIOGRAPHY

1. Abbot, D. P.: Primary actinomycosis of the kidney. Jour. Am. Med. Assn., 82:1414-1415 (May 3), 1924.
2. Beregoff, Pauline: Renal actinomycosis with particular reference to the urinary findings. Michigan State Jour., 28:383-385 (May), 1929.
3. Bevan, A. D.: Actinomycosis of the kidney. Surg. Clin. N. Amer., 3:899-902 (Aug.), 1923.
4. Christison, J. T., and Warwick, Margaret: Actinomycosis of lungs and supra-renals. Jour. Am. Med. Assn., 89:1043-1047 (Sept. 24), 1927.
5. Cohn, Theodor: Pyonephritis et Prostatitis actinomycotica. Berl. klin. Wchnschr., 2:1497-1499 (Aug.), 1911.
6. Israel, James: Primäre Actinomycose der Niere. In: Chirurgische Klinik der Nierekrankheiten. Berlin, August Hirschwald, 1901, pp. 266-273.
7. Israel, James: Ein neuer Fall von sog. primärer Nierenaktinomykose. Folia urolog., 5:447-451 (Jan.), 1911.
8. Kleinschmidt, P.: Zur Kasuistik der primären Nierenaktinomykose. Arch. f. klin. Chir., 120:658-661, 1922.
9. Kunith: Ein Fall von primärer Nierenaktinomykose. Deutsch. Ztschr. f. Chir., 92:181-184 (Feb.), 1908.
10. Peacock, A. H.: Actinomycosis of the kidney. Northwest Med., 24:173-176 (April), 1925.
11. Pinner, Hans: Beitrag zur Nierenaktinomykose. Ztschr. f. Urol., 16: 187-191, 1922.
12. Stanton, E. MacD.: Actinomycosis limited to the urinary tract. Am. Med., 11:401-403, 1906.
13. Von Lichtenberg, Alexander: Primäre Nierenaktinomykose. In: Handbuch der Urologie. Berlin, Julius Springer, 1927, 4:225-234.

A DISCUSSION OF CERTAIN PHASES OF RENAL TUBERCULOSIS

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Since urinary tuberculosis has been so thoroughly studied and its clinical manifestations so definitely standardized, little opportunity is left for a presentation of exciting interest.

This subject, however, remains one of the vital problems in urology. For instance, Sellaris and Vonderbecke found, in a series of 1,724 patients with urological lesions, that 16 per cent had renal tuberculosis. Kuster stated that 10 per cent of patients dying of tuberculosis had kidney involvement. In 85,000 operations at the Mayo Clinic, .6 per cent were for this disease. Kapsammer, in 20,000 autopsies, showed 196 cases of tuberculosis of the kidney, or about 1 per cent.

It has been my impression for some time that renal tuberculosis, the chief source of urinary tract tuberculosis, is definitely declining in frequency and that nephrectomies for tuberculosis have not appeared on the operative list as often as in the past.

In order to substantiate this impression, I have compiled the proportion of cases which have entered my service at the Barnes Hospital in relation to all other diseases. Through this analysis, tentative suspicions have been transformed into definite facts.

There were admitted into the Barnes Hospital from 1916 to 1921, 100 cases of renal tuberculosis, or an average of twenty cases a year. From 1921 to 1929, there were 146 cases, or sixteen a year.

In ascertaining the comparative frequency of renal tuberculosis to the total hospital admissions for all diseases I analyzed two three-year periods, 1919, 1920 and 1921, and 1927, 1928 and 1929. In the former the ratio was 1 to 304, in the latter it was 1 to 400, a decline of about 25 per cent. The year 1921 showed the greatest number of tuberculous cases but this seems a pure coincidence.

Jeck in reviewing the operations for tuberculosis of the kid-

ney in the Bellevue Hospital noted a decided increase in the percentage of tuberculous nephrectomies through the years 1919 and 1920 and attributed it to the effects of the war upon the general health.

To offset any effects of a specific temporal influence, I compared the years of 1916, 1917 and 1918 to 1927, 1928 and 1929 and found there was still a definite difference in the two periods, namely a 15 per cent reduction in the latter period.

The proportion of tuberculous to non-tuberculous kidneys in our clinic bears a ratio of 1 to 5. In non-tuberculous infections, urological expertness has exerted a tremendous influence in reducing the necessity for surgery, and the conduct of routine investigation for the source of pyuria and prompt therapeutic regime for its correction with the ureter catheter have been the significant agents, but in tuberculosis we have no such claim.

Greater efficiency would, of necessity, reveal earlier lesions and hence more frequent incidence of the disease and, with our present day therapeutical practices, more frequent surgical operations.

My series shows fifty-five operations from 1916 to 1921 and fifty-three operations from 1921 to 1929, so that neither the proportionate number of cases of the disease nor the number of operations are as frequent at the present time.

Other general factors enter into the picture to receive honor for this reduction. Medical teaching, through which the average human subject has gained an experience of how to live and how to eat, has had unquestionably a definite effect. The craving for fresh air, moderate exercise, and recreative desires has been contributing a feature; but, above all, accurate and early medical diagnosis, along with proper teaching of hygiene, systematic therapeutic care and attention to the patient have been the paramount factors in the reduction of the general destructive effects of tuberculosis.

The enormous increase in sanatorium care with all its facilities, the isolation of patients and the instruction of patients to care for themselves properly, thereby preventing the spread of disease, and other factors such as medication, heliotherapy and diet have shared in this picture.

Through these tremendous influences massive general tuberculosis has been decidedly curtailed.

Renal tuberculosis is secondary to pulmonary tuberculosis in almost half of the cases; in this series it was 41 per cent.

The blood stream of the tuberculous subject is said to be low in fats and cholesterols and hence the feeding of fats, particularly butter fats, is believed by many to be one of the great factors in the healing of tuberculous lesions. It is for this that the Sauerbruch diet has been responsible for such remarkable results in Germany. Tuberculous lesions, in experimental animals, have been definitely modified by fat ingestion. Vitamins are also important.

For much of this information I am extremely thankful to Dr. Bredick and Dr. Bell, of St. Louis, who are devoting their entire time to the subject of tuberculosis.

The proper herding of cattle, tuberculin testing, and pasteurization of milk, all have had their effect upon this general improvement.

The death rate in St. Louis from 1917 to 1919 was about 210 per hundred thousand. At the present time it is around 160 to one hundred thousand.

In the last twenty-six years the general death rate has been reduced almost 50 per cent. The St. Louis Koch Hospital in 1919 had a capacity of 186 patients and during the year 250 deaths. In 1929 the capacity had increased to 460 and the death rate was practically the same. It is thus evident that renal tuberculosis has followed the decline of general tuberculosis.

Nephrectomy for tuberculosis is said to comprise about 30 per cent of all surgical operations upon the kidney. A report of my cases in 1921 showed it to be 22 per cent, between 1921 and 1929, 17 per cent, or an average of 19½ per cent, that is there were 108 operations for renal tuberculosis in 550 surgical operations upon the kidney. These 108 operations were taken from a series of 246 cases, or 44 per cent. The remaining 56 per cent were not operated upon either because the lesion was bilateral or the patient was a subject of general massive miliary tuberculosis. About one-third of the patients not operated upon were truly operable cases but either refused operation or were advised against it by their physicians, who believed that medical care and general hygienic measures, which have been enumerated, would cure them.

This again brings for our discussion the healing of renal tuberculosis.

While it is perfectly true that certain investigators have shown experimentally, in animals, that tuberculous processes, namely, tuberculous nephritis and certain embolic lesions which have been traced by repeated biopsy studies, have definitely healed, these pathological processes showed no parallelism to the type of chronic surgical tuberculosis which we are here discussing.

I observed the healing of multiple subcapsular tubercles in the kidney of a young girl whom I had previously operated on for stone in the only kidney, the other having been removed, prior to this, for tuberculous pyonephrosis. At the first operation on this kidney, which was a pyelotomy, the surface of the kidney was studded with numerous typical tubercles. After the stone was removed from the pelvis of the kidney, the organ was allowed to remain in the air for some time for the beneficial effect upon healing. At the second operation, which was a nephrotomy for recurrent stone, the tubercles had entirely healed.

Another interesting phenomemon of tuberculosis occurred in this same patient; in exposing the kidney for nephrectomy owing to dense adhesions the kidney was completely ruptured, almost completely transversely. It was sutured without untoward effects and the healing was without delay.

Medical literature has asserted that there has not been definitely proved a single case of healed chronic surgical tuberculosis.

Chronic surgical tuberculosis is a slow, indolent process starting usually in one kidney; on this most authorities agree. Since the renal process is so notoriously silent in its earlier stages—for instance only 20 per cent of the 246 cases in my series presented renal pain—the initial lesion gradually progresses, tubercles coalesce and follow their tendency to break down and form an abscess cavity or cavities. Nature's response to this activity is the creation of an almost impregnable wall of defense in the composition of scar through which circulatory influences from without are decidedly interfered with and nutrition disturbed.

In the meantime, the bladder and ureter are bathed in the infected urine resulting from this lesion. The difficulty of infecting the bladder mucous membrane under normal conditions is evident to all and hence the first symptom of renal tubercu-

losis in at least 75 per cent of cases, namely bladder irritability, results very late in the course of the disease, and in addition the three years' average before such kidneys are thoroughly and specially studied makes it easy to understand why healing is practically impossible and not at all comparable to the simple superficial processes which have healed following experimental production.

Hesitation results also in gradually increasing the percentage of bilateral involvement either through the blood stream or by back-wash up the ureter from incompetency of the valve due to infiltration. Regurgitation is more frequently seen in tuberculosis than in any other disease of the bladder.

In my series of patients the average duration of symptoms was two years and nine months, certainly sufficient time for such complications to ensue. Thirty-one per cent were bilateral. This is decidedly higher than the current statistics.

Wildbolz found seventy-eight bilateral cases in 600 nephrectomies. Legueu states bilateral conditions should not exceed 15 per cent. Halle and Motz report 20 per cent bilateral.

Rafin found at autopsy the condition bilateral in 47.6 per cent, one side being far less advanced than the other. Braasch considers that bilateral renal tuberculosis occurs more commonly than the usual data indicate.

If the ureter remains free, the process in the kidney will usually continue silently. The only way in which a kidney may apparently heal is through its occlusion by ureteral stricture with subsequent autonephrectomy, occasionally by localized isolations in certain portions of the kidney. These processes, however, show a tendency to recurrences. Through this pseudo-healing, the bladder may become improved, but I have never seen a single case entirely relieved of bladder symptoms in spite of the fact that its appearance was much better than the symptoms would indicate. The kidney, in my experience, has always shown definite tuberculosis.

In this series of 246 cases there have been twenty-six autonephrectomies, over 10 per cent, a strikingly high percentage of this type of renal pathology. Keyes states that about one or two are autonephrectomies.

Older patients have more of a tendency to this condition, yet I have seen several very extensive and far advanced lesions in

young children. The youngest patient with autonephrectomy was 19 years old. This child had a complete calcification of kidney and ureter, visible by plain X-ray plate. The implantation of the ureter into the psoas muscle had been responsible for a flexion and rotation of her hip which simulated tuberculosis of the hip, for which she had been treated for several years. The removal of the kidney and ureter cured the hip condition.

The average age of patients was thirty-one and one-half. There were 232 whites and fourteen blacks. Fifty-nine per cent of these patients were males and 41 per cent females. Six cases occurred in chldren under 12 years of age.

It is interesting to note the great preponderance of whites over blacks, since tuberculosis is so much more frequent in the colored race; but the disease is much more virulent, as the negroes' resistance is low and massive tuberculosis is the rule. Chronic surgical tuberculosis is, therefore, naturally less often seen.

In our series of 14 cases, however, 50 per cent of the blacks had general tuberculosis. The other 50 per cent were unilateral cases and the patients were nephrectomized. Of the seven patients not operated upon four died in the hospital with generalized tuberculosis.

Resistance is low in children and massive tuberculosis is the rule, as in the colored race. Hempelman found that 78 per cent of the children with tuberculosis during their first year died within the year and that 68 per cent of those who are found with tuberculosis in their second year died within a year.

Genital lesions, namely epididymitis, prostatitis and vesiculitis were found in 71 per cent. Epididymectomy was performed in 18 per cent of the cases in this series.

There is nothing striking in the symptoms: frequency, urgency, pain and hematuria, except that 50 per cent of these patients showed definite hematuria. Profuse bleeding was the only symptom in four cases.

The diagnosis of renal tuberculosis is a problem of great concern to us. In the atypical cases such as those starting with profuse hemorrhage with negative vesicle findings, and in early cases with slight irritabilities of the bladder with no definite cystoscopic evidences and with negative renal findings through the ureter catheter, it is at times quite difficult to arrive at an early

accurate diagnosis. Here repeated studies are necessary and all available methods must be utilized.

The average case of renal tuberculosis, however, is not such a difficult problem to unravel.

Sacral anesthesia is most helpful, not only for the ease of cystoscopic study to both patient and operator, but particularly for the ability to interpret properly the bladder picture undisturbed by spasm.

For me to discuss the different methods of diagnosis that are so familiar at the present day is entirely unnecessary. I do wish to stress a few features of this particular phase of the subject. While many authorities say there is no bladder picture typical of tuberculosis and that the cystoscopic appearance of the bladder may be greatly misleading, I am thoroughly convinced in my own mind that, coupled with a history suggesting tuberculosis of the urinary tract, the cystoscopic picture of the bladder is the most definite single finding of urinary tract tuberculosis. In my series, 78 per cent were definitely and positively diagnosed as tuberculosis through cystoscopy. The ureter catheter must then decide whether the process is renal, and, if renal, whether one or both kidneys are involved.

With a positive bladder picture and the finding of pus without bacteria in ordinary stains from a kidney, renal tuberculosis is almost always present and, whether I find tubercle bacilli or not, or whether the guinea pig is positive or not, if this condition resists a few lavages, I feel positive in my own mind that renal tuberculosis is present.

It is supposed that the tubercle bacilli are found in about 85 per cent of the cases. I am disappointed to say that in searching my records it is embarrassingly less. The difficulty and tediousness of searching for these organisms make the busy houseman pass the slide as negative on many occasions when a diligent search would, in all probability, have revealed it and without any particular methods of fixation or centrifugalization.

The X-ray may be helpful in diagnosis. The presence of calcification in the kidney region or complete calcification of the kidney will occur in a certain percentage of cases. In my series it has been less than 10 per cent.

Urography has an important place in the diagnosis. I have routinely used it on almost every patient with renal tuberculosis

and have yet to see any trouble resulting from it. In many instances it gives no information. It, however, fortifies the examination in a great many cases and in a few may give the only positive evidence of the disease. The fuzzy, fringed localized lesion in the region of a calix is very significant. The ureteral or pelvic impression is often characteristic and very helpful in the final summing up of the case, and, while this procedure is not absolutely essential in most cases, I feel that it adds to the charm of the diagnosis without unnecessary hazard to the patient, if properly executed.

Perinephritic abscess occurred in 5 per cent.

The present interpretation of the treatment is early nephrectomy, provided the lesion is unilateral. In bilateral tuberculosis the only excuse for surgery is in the case pyelonephrosis of one kidney and a faith that the patient may receive temporary benefit from the relief of toxemia without entertaining hope of arresting the process in the mate. Very rarely bilateral drainage may be required.

I do not believe that the removal of the more diseased of two tuberculous kidneys as an operation of choice is advisable. The few cases which have been reported as cured are in all probability mistaken diagnoses, and what appeared to be a bilateral renal lesion was a contamination of the other ureter due to back-wash from the infected bladder. I have personally seen no benefit in the few cases which I have done either to the remaining kidney or to the bladder.

One is faced occasionally with another rare indication for surgical attack in bilateral tuberculosis or in the case of a single remaining tuberculous kidney, where its mate has been removed, in order to relieve the distressing symptoms from intractable tuberculous cystitis. Ureterotomy serves the best purpose for this condition. It is certainly to be desired to renal drainage and suprapubic cystostomy. I had one girl live in comfort five years after this.

In nephrectomy for renal tuberculosis delicate handling of tissues is very important. Removal of all the perirenal fat that is possible is definitely indicated, since the fat, rich in lymphatics and prone to infection, is the responsible factor for the persistence of renal sinuses.

Kretschmer called attention to this a number of years ago and

it has been my observation that every sinus which has been indolent in healing could be traced to the region of the renal bed and not to the stump of the ureter.

With reference to the ureter in the surgery of the tuberculous kidney I feel that most surgeons are in accord that the ureter, like the bladder, usually heals without molesting the individual to any considerable extent. Some operators feel that complete removal of the ureter along with the kidney is essential, others are convinced that its section at a convenient location is all that is necessary. Still others believe that dealing with the ureter is dependent upon the type of the ureter which is present.

Judd advocates draining the large badly infected tuberculous ureter by the insertion of a catheter, others are convinced that the ureter must be brought into the wound for drainage and topical application.

I am decidedly convinced, after analyzing the 108 cases which have been operated upon in my clinic, that one does not need to magnify the importance of the ureter, that its ligation at a convenient place, allowing it to drop back into its bed, is all that is necessary.

In these cases I have seen but one ureter which has later caused difficulty and this was a patient who three years after nephrectomy presented herself with a pain in her lower right quadrant and slight elevation of temperature. I found that the ureteral orifice was pin-point and that there was ureteral retention of inspissated pus; after dilatation of the opening, the patient was promptly relieved and has had no further trouble for at least five years.

Young reports but one case in 112 nephrectomies in which the ureter had to be removed later.

The necessity for proper anesthesia, proper position of the patient and ease in surgery and rapidity of technic, as well as careful closure, need no particular comment.

It is my custom to drain all tuberculous wounds. I have closed a number, but about 25 per cent have later opened and I see no particular advantage in closing and this really proves to me the necessity of a small drain.

The ureter is a very valuable adjunct in the surgery of the tuberculous kidney and it is my custom to ligate the ureter first and use the proximal end as a tractor, thereby giving more ade-

quate exposure to the pedicle and definitely simplifying the removal.

The average length of time these patients have remained in bed is twelve days; average duration in the hospital is twenty-five days. This is high because a few patients required longer hospitalization. Eliminating these, the tuberculous patient usually is discharged within three weeks.

In none of these cases has there been a rib-resection and, while the reports indicate that such resections do not complicate the operation, I feel that in this type of lesion it is definitely desirable not to subject the bone or the lung to the possible spread of tuberculosis.

The healing of the bladder and the relief of symptoms after nephrectomy is a subject of extreme interest. Lower states that the relief of symptoms after nephrectomy is usually about as long as the duration of symptoms before operation. It appears to me that no definite rule can be laid down concerning this. It has been my experience that the more active the bladder lesions the more acute the symptoms, the more prompt the healing.

There is no parallelism between the amount of renal destruction and the character of the vesical lesion.

Some of the late, almost completely destroyed kidneys, may reveal little evidences of vesical tuberculosis whereas the small walled-off abscess in one or the other pole of the kidney may be instrumental in the production of a tremendous reaction in the bladder, and a bladder more acutely involved will ofttimes heal more rapidly and the patient be more quickly relieved than with a process which appears less active.

The explanation of the rapidity in healing and relief of symptoms of the angry, acute bladder, after the removal of an active tuberculous lesion in the kidney, has been considerably discussed. Keyes feels that it is dependent upon the diminution and the total amount of urine, and believes that, since the bladder receives only half the amount of urine after the removal of the kidney, its quiescence is due to this.

I have seen a fair number of patients of this type who urinated every fifteen minutes, day and night, and suffering with severe pain and tenesmus, who, twenty-four hours after the removal of the kidney, could hold the urine two or three hours and pass six ounces of urine instead of one-half ounce to an ounce, the

bladder at this time being just as studded with ulcers and visible inflammatory reaction as it was previous to the surgery, a condition comparable to the crisis in pneumonia. The patient is a sensitized individual, and this result is due to the relief from a tuberculin reaction. During the activity of the process in the kidney the products resulting from the lesion, namely dead tissue, bacteria, dead and alive, tuberculo-proteids, fats and fatty acids, keep up a constant tuberculin reaction on the raw surface in the bladder wall. Upon removal of the kidney this tuberculin reaction is immediately relieved and the patient's symptoms are promptly ameliorated. This reaction may be reproduced by the injection of tuberculin. Formerly when I was using tuberculin as an adjunct to the healing of tuberculous lesions, I observed a number of these reactions in bladders which had previously quieted down and noted the subsidence of this response after the tuberculin reaction had passed.

Many of these individuals go on to gradual healing without recrudescence; the majority, however, pass through flurries of reactions due to the persistence of ulceration and vesicle wall infiltration.

It is very hard to predict the length of time necessary for the bladder to heal. For instance, I have recently seen two patients who had the same type of renal lesion and the identical involvement of the bladder mucous membrane. One patient within a week showed such astounding healing that it was impossible to detect the ulcers and tubercles which had been previously demonstrated. On examination before nephrectomy I was anxious to have the artist draw the bladder picture, which showed a typical collarette of tuberculous ulcers and tubercles around the orifice of the ureter and a large ulcer on the posterior wall. When I again made a cystoscopic examination of this patient a week later these had so definitely healed that it was difficult to determine their previous location. This patient at the present time, three months after the operation, is perfectly free from bladder symptoms and has a normal bladder, as shown by cystoscopy.

The other patient has gone ten years after nephrectomy in perfectly good health but has been constantly bothered with frequency of urination, getting up from three to five times at night.

The urine was sparklingly clear but on cystoscopic examination there was a large ulcer seen on the posterior wall and base of the bladder which had evidently been present all of this time. Following electro-coagulation and gradual vesical distention she was very promptly able to sleep through the night with but one interruption and has a bladder capacity of 12 to 15 ounces.

The persistence of bladder symptoms after operation may depend on several factors:

1. The invasive tendency of the disease with its resulting bladder contracture is one of the most important and speaks for the necessity of early nephrectomy.

2. In a few instances contracture of the vesical neck may be responsible; there have been three cases in this series and two have been relieved by the Punch.

3. Tuberculosis of the opposite kidney and remaining tuberculosis in the genital tract.

I have never been enthusiastic over the ureteral stump as the cause of bladder symptoms.

A comparison of the results of renal tuberculosis treated by nephrectomy and those treated expectantly immediately indicates the folly of medical treatment. In 1925 Parsons showed 85 per cent of the patients were dead within five years. Wildbolz in 316 non-operated cases showed 58 per cent died within five years and only 6 per cent were living more than ten years. On the other hand in 104 nephrectomies, which he performed in a certain period, 55.7 per cent of the patients were completely well at the end of ten years. Sutter showed 61 per cent well between eleven and seventeen years after operation. Of 863 patients at the Mayo Clinic 58.1 per cent were cured four years after operation.

In this series of cases I have been able to follow fifty-six patients, or 51.9 per cent of those who were operated upon; these were principally private patients. Of these, forty-three, or 77 per cent, are well and entirely free of bladder symptoms; 23 per cent have remaining evidences of the disease, or have died. In the former group of the well patients, thirty-four, or 79 per cent, have passed the five year period; nineteen, or 44 per cent, are living and well after ten years. Thirty-five per cent have lived from eleven to nineteen years after operation. About 30 per cent of the patients in the group not completely well are

suffering with symptoms of bladder irritability. Several of these have been followed and the condition found to be due either to contractures of the bladder or to ulceration. They have been greatly relieved by local measures, thus signaling the necessity for proper supervision of these patients after operation.

I believe that if a patient is relieved following operation and remains perfectly well for a year, he is likely to remain permanently cured.

The immediate mortality of nephrectomy for tuberculosis, in the hands of trained surgeons, ranges between 2 and 4 per cent. Wildbolz shows 2.4 per cent, Mayo Clinic 2.7 per cent. Numerous operators have reported a considerable series without a death. There has been no death in the 108 cases here reported.

In this series there have been three operations on single tuberculous kidneys, the mate having been previously removed. One was a nephrostomy for stone, another a pyelotomy for stone, and the other case was a nephrostomy with ureteral ligation for the relief of the intractible bladder.

There have been several other interesting complications in this series that I shall take the liberty of mentioning. One patient, a girl, had a spontaneous rupture of the bladder at the site of tuberculous ulcer on the posterior wall. There was one instance of association of tuberculosis and cancer of the bladder. Another patient had complete calcification of the kidneys. When I saw him the same condition had been present for eight years. At the time of my first observation, and during his life, which was twelve years longer, or a total period of twenty years, there was scarcely a trace of phthalein in his urine and yet he enjoyed fair health and was able to attend to his important duties of teaching in a public school. During all of this time he had recurrent attacks of profuse hematuria.

Another patient, referred to above, had a calcification of kidney and ureter which had involved the psoas muscle to such an extent that she had been treated for chronic tuberculosis of the hip. Another, a very young girl, presented an impermeable stricture of the urethra with incontinence. The whole urethra was a solid cord and was most difficult to dilate. This is the only occasion, in my series, where stricture of the urethra complicated tuberculosis. I have seen incontinence of urine in one more individual, a woman with a small contracted bladder, incom-

petent ureteral valves, regurgitation up the ureter with marked dilatation of the ureters and renal pelves. The urethra was apparently normal. I could find no evidence of obstruction and her nervous system was negative. I was unable to dilate the bladder by hydraulic distention because of the renal colics immediately produced.

SUMMARY

1. Renal tuberculosis is declining in frequency as a result of the improvement in the early diagnosis and treatment of pulmonary and general tuberculosis and the prevention of massive lesions.

2. Early diagnosis in renal tuberculosis is paramount.

3. The cystoscopic picture is most significant.

4. In unilateral renal tuberculosis, nephrectomy should be performed promptly.

5. Surgery in bilateral renal tuberculosis is indicated only in cases of emergency to relieve toxemia from pyonephrosis or to correct intractible vesical lesions.

6. The immediate relief of symptoms in many of the cases after nephrectomy is due to the removal of a tuberculin reaction created by the products of bacteria, dead and alive, tuberculoproteins, fats, and fatty acids.

7. Ofttimes the more acute the lesion in the bladder, the more quickly the healing and relief of symptoms following the removal of the diseased kidney.

8. The chance of healing in chronic renal surgical tuberculosis is remote and not comparable to the simple early experimental lesions.

9. The mortality of nephrectomy is exceedingly low.

10. The relief of bladder symptoms may be expected in at least 75 per cent of the cases of unilateral renal disease instead of an almost positive assignment to invalidism if left to medical care.

MIXED TUMORS OF THE KIDNEY IN INFANCY AND CHILDHOOD

A STUDY OF SEVENTEEN CASES

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This paper is based upon a study of seventeen cases of malignant tumors of the kidney which occurred in infancy and childhood. Some of the tumors were under our personal observation and some of them were studied from pathological specimens removed from patients on the services of others at the Children's Memorial Hospital and the Presbyterian Hospital of Chicago.

One of the interesting phases of this tumor study that was brought out in these cases was the fact that in many of them the true nature of the tumor was not recognized either at the time of operation or at the time the histological examination was made. For example, a review of the histopathological diagnoses showed the following diagnoses: Multiple cell type sarcoma, myxomatous tumor, alveolar round cell sarcoma, myxomatous sarcoma, and, in one instance, a diagnosis of hypernephroma was made. But a careful histological study of these tumors showed that the tumors so designated had been wrongly diagnosed and a careful subsequent study revealed the fact that they belonged to the interesting group of cases of mixed tumors.

Malignant tumors of the kidney occurring in infancy and childhood are rare, as may be seen from a review of the older as well as the recent literature. Thus, Bugbee and Wollstein, in a review of 4,903 autopsies performed on infants and children, report no cases of malignant renal tumor. Lowsley and Butterfield, in a recent series in which they reported their findings in 100 cases of urological lesions in infancy and childhood, mention no case of malignant tumor; and Thomas and Birdsall, in an exhaustive report of their experiences in children, do not include any cases of malignant renal tumor. On the other hand,

Magoun and McCarty reported a series of seven cases of malignant tumors in children.

According to Thomas, tumors of the pelvis of the kidney in infancy and childhood are rare when compared with the occurrence of tumors of the renal parenchyma, and he reported a very interesting type of tumor of the kidney pelvis. Deming some time ago reported a case of congenital sarcoma that occurred in a child twenty-nine days old. Hyman, in a series of seventy renal neoplasms, reported ten cases of mixed tumors. Hasner recently reported four cases of mixed tumors of the kidney, three in infants and children and one in a man aged forty-five. Recently Wollstein reported a series of eighteen cases of malignant tumors of the kidney in children; seventeen of them were mixed tumors.

That malignant tumors occur in other organs during infancy and childhood is evident from a somewhat cursory review of the literature. Among recent articles dealing with this subject are the following: Angiosarcoma of the Liver (Bondy); Primary Carcinoma of the Liver (Castle); Tumors of the Ovary (Downs); Sarcoma of the Small Intestine (Fullerton); Carcinomatous Ovarian Teratoma (Harris); Sarcoma of the Bladder (Mixter).

It is evident, therefore, that the kidney is not the only organ that may be the seat of malignant disease in infancy and childhood. However, as regards the frequent site of malignant disease in the genito-urinary tract, the kidney easily heads the list, and the common tumor is the so-called mixed tumor of Wilms.

The following seventeen cases form the basis of this report.

Case 1.—B. N., female, white, aged one year, was admitted to the Children's Memorial Hospital on the service of Dr. Joseph Brennemann, August 28, 1928.

Complaint on entrance was of a mass on the left side of the abdomen. About four months ago, that is, at the age of eight months, the mother noticed some distention of the left side of the abdomen. The mother stated that she did not think the child had lost weight but there was no gain in weight and her color was poor. There were no other symptoms.

Physical examination revealed a fairly well-nourished child, rather pale, with a prominent abdomen. Heart and lungs, negative.

Examination of the abdomen disclosed a very prominent, visible mass filling the entire left side. The mass extended from the arch

of the ribs to the crest of the ilium and beyond the midline at the level of the umbilicus. It was smooth and firm and not tender.

Temperature was 100 degrees.

Blood examination showed: Red blood cells, 3,000,000; white

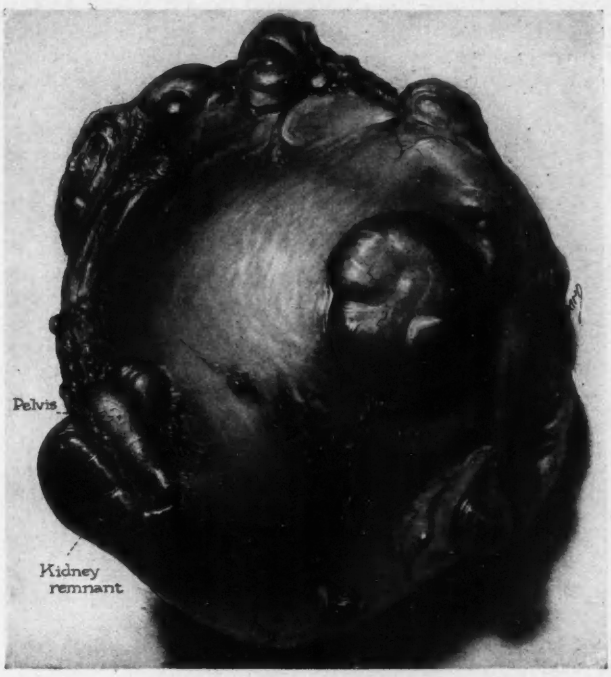

Fig. 1. Case 1. Kidney and tumor removed surgically. Small remnant of kidney tissue. Slight dilatation of the kidney pelvis. Nodular surface of the tumor which in general outline is circular.

blood cells, 19,200; polymorphonuclear neutrophiles, 67 per cent; lymphocytes, 30 per cent; transitionals, 3 per cent.

Urinalysis report was: Clear; reaction, acid; albumin, 0; sediment, no blood cells and 30 pus cells per cubic millimeter.

Cystoscopic examination showed the bladder to be normal. Ureters were catheterized without obstruction. Urine from the right kidney was normal. No urine was obtained from the left kidney.

Roentgen-ray examination of the chest was negative.

Pyelogram showed the right kidney to be normal. No fluid entered the left pelvis.

Pre-operative diagnosis was a malignant tumor of the left kidney.

Operation was performed September 28, 1928, under ether anesthesia (Dr. H. L. K.). The usual oblique kidney incision was made through the skin, fascia and muscles. A large, solid tumor of the kidney, about the size of the patient's head, was found. The veins covering the tumor were unusually large and tortuous. The surface was smooth; consistency firm; color gray. The tumor extended up under the costal arch above and into the iliac fossa below, and beyond the midline. Because of its size and its fixation it was decided not to do a nephrectomy. Two pieces of tissue were removed for histological study.

The patient had an uneventful convalescence, and it was advised that she be given deep X-ray treatment.

The patient was admitted to the Presbyterian Hospital for deep X-ray treatment and treated by Dr. C. B. Rose, who gave twenty-seven treatments. During the course of roentgen-ray treatments there was definite diminution in the size of the tumor. At the end of the course the tumor remained stationary, and nephrectomy was advised.

On December 5, 1928, the patient entered the Children's Memorial Hospital, a second time.

Examination was made by Dr. Joseph Brennemann January 7, 1929. The general examination gave no additional information, no evidence of metastases, and Dr. Brennemann concurred in the plan to carry out a nephrectomy.

Blood examination showed: Red blood cells, 2,864,000; white blood cells, 13,400; hemoglobin, 50 per cent.

Urinalysis report was: Reaction, acid; albumin, trace; sugar, 0; 20 white blood cells per low power field; blood, 0.

Roentgen-ray examination of the chest was negative for evidences of metastasis.

Temperature varied from 100 to 101 degrees.

Operation, left nephrectomy, was performed January 10, 1929, under ether anesthesia (Dr. H. L. K.). The tumor mass was freed with a great deal of difficulty because of the presence of adhesions. During the course of the dissection a rent in the diaphragm and a tear in the peritoneum occurred. The tear in the diaphragm was sewed with catgut and the opening in the peritoneum was closed with a running suture of catgut.

Convalescence was uneventful.

Histological diagnosis was adenomyosarcoma of the left kidney.

A recent examination revealed the presence of large tumor masses in the abdomen and roentgen-ray examination of the chest showed the presence of pulmonary metastases.

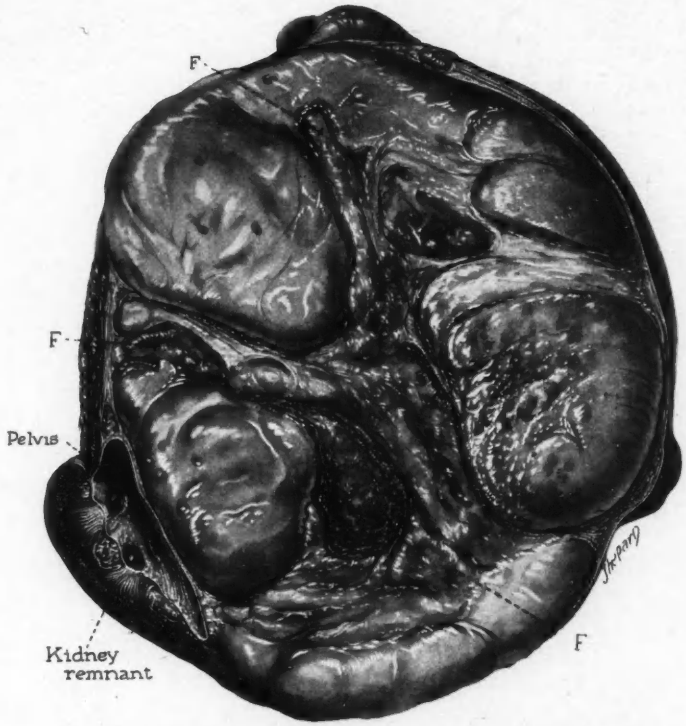

Fig. 2. Case 1. The surfaces made by cutting: Showing remnant of kidney with some dilatation of the pelvis and exceedingly large quantity of fat, *F*.

The child died, May 18, 1929, four months after the nephrectomy. There was no autopsy.

Description of Specimen Removed at Operation.—The kidney and tumor mass together weighed 1,738 grams and measured 17x13.5x 14.5 cm. in maximum dimensions. The mass in general was oval. Its surface was smooth except for lobulation depressions of the tumor mass and for twelve nodulations of the surface, three of which were 2 cm. in diameter, and the others 3 to 3.5 cm. in diameter. The nodulations bulged outward from the central tumor mass and each was covered with a common capsule. The entire mass was firm. It flattened only slightly when placed on a hard table and was generally a gray to light brown. Delicate blood vessels only were present, and these were distended. In places the mass was dark red to brown, apparently because of old blood and new dark tissue.

Firmly attached to the upper pole was the remnant of this kidney. Grossly the kidney tissue was sharply defined, normally lobulated, dark brown, and its surface was flattened out so as to be continuous with the general contour of the mass. The total kidney substance present measured about 3.5 cm. in diameter and weighed approximately 30 grams. Upon four transverse serial sections of the entire mass, the surfaces made by cutting were uniformly firm throughout all portions and consisted of clumps of tissue 3 to 4 cm. in diameter, of a mottled gray to light brown, surrounded by narrow bands of densely rigid fibrous-like tissue. A center nodule was light yellow-brown, easily friable, and was evidently the result of pressure necrosis. Near the periphery of the mass at the lower pole there was a sharply defined dark brown spongy-porous nodule 3 cm. in diameter. Nowhere was there any substance that was not cut easily by a sharp knife.

In histologic sections of the tumor the tissue consisted of densely packed cells which stained deeply. Although most of the cells were in clumps, many of them were arranged in bundles, that is, the nuclei were parallel, and about half of the cells had deep chromatin staining properties and the other cells were either diffusely granular, two or three times as long as they were wide, and many of them were vesicular. Between clumps of cells isolated eosinophilic polymorphonuclei were present. The nuclei that were vesicular were generally more spherical than oval. The cytoplasm generally was in strands and these stained pink and had transverse striations. Throughout the sections there were sharply defined tubular gland structures. These tubules in general were most abundant where the epithelial cells were densest. Nuclei of the tubular gland cells stained deeply; they were more oval than round and were situated in the mid-portion of the cell, which was semi-columnar in shape. In the lumen of the tubules the content was of non-cellular globoid

structure and celle detritus. Where the tissue was less cellular the nuclei were more spherical and here isolated lymphocytic polymorphonuclears were present. In the central portion the nuclei stain was faint, the cells were scantty, and the cytoplasm was grossly granular and stained poorly, as in pressure necrosis. Here leukocytes were moderately abundant throughout, but in places they were present in clumps.

In sections stained with phosphotungstic acid hematoxylin, there were dense striated muscle fibers in bundles. These fibers and bundles

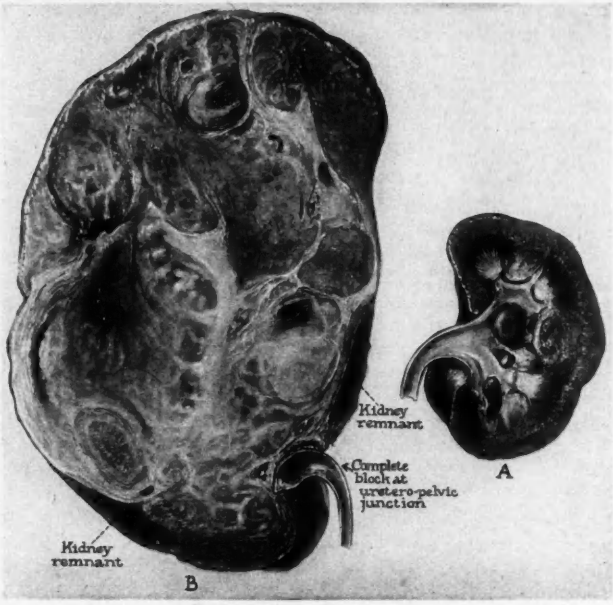

Fig. 3. Case 2. *A*, Normal kidney. *B*, Tumor removed at operation. Only a small remnant of kidney tissue remains at the lower pole. There is complete block at the ureteropelvic junction.

ramified throughout the epithelial cell masses, but were more abundant surrounding the clumps of epithelial cells than in them. In places the transverse striations of the muscle fibers were so compact that the fiber resembled a coil spring. Elsewhere the striated muscle fibers had a heterogeneous arrangement.

The sections of the nodular surfaces made by cutting consisted of compact epithelial cells with deep chromatin stain and were surrounded by a loose net-work of cells with finely granular, almost

spherical, nuclei which stained faintly. Here red blood cells were present out in the tissue and in the delicate capillaries.

Sections of the tumor removed four months after surgical exploration of the tumor with biopsy, were essentially similar.

Case 2.—H. D., male, white, aged two years, referred by Dr. Reichert, was admitted to the Children's Memorial Hospital on the service of Dr. Joseph Brennemann, September 5, 1928.

The mother had noticed the presence of a large mass in the abdomen one month prior to admission. The mass had definitely increased in size. It was the mother's opinion that the mass fluctuated as to size, at times being larger and at other times smaller; but her general impression was that the mass had become definitely larger. There were no subjective symptoms except that the child appeared to be weak and poorly nourished.

Physical examination revealed a poorly nourished, anemic, flabby child, active and mentally alert. Head, neck and lungs were negative. A systolic murmur was heard at the base.

A large mass in the left upper quadrant of the abdomen was more easily palpable in the flanks than anteriorly. The mass was smooth, firm and irregular in outline.

Temperature on admission was 102 degrees. During the child's stay in the hospital it varied from 102 to 103.5 degrees.

Blood examination showed: Red blood cells, 2,000,000; white blood cells, 9,000; hemoglobin, 40 per cent; polymorphonuclear neutrophiles, 51 per cent; lymphocytes, 44 per cent; eosinophiles, 3 per cent; transitionals, 2 per cent.

Blood chemistry examination showed: Urea, 60; urea nitrogen, 28; uric acid, 5.5; creatinin, 1.6; non-protein nitrogen, 44; cholesterol, 250.

Urinalysis showed a faint trace of albumin; pus, 0; blood, 0; casts, 0.

Wassermann test was negative. Father's and mother's Wassermanns were likewise negative.

Roentgen-ray examination of the chest was negative.

Cystoscopic examination showed the bladder to be normal. The right ureter was catheterized. Examination of the urine obtained from the right kidney was negative. Left ureter was not catheterized.

A pyelogram of the right kidney indicated that it was normal.

Preoperative diagnosis was tumor of the left kidney, probably malignant, and operation advised. This was refused.

The patient was admitted to the hospital a second time, October 16, 1928. One week before this admission there had been bright red blood(?) in the urine.

Operation was performed October 16, 1928, under ether anesthesia (Dr. H. L. K.). The usual oblique kidney incision was

made. An exceedingly large tumor of the left kidney was found, the whole mass being firmly bound down by adhesions. Because of its enormous size and difficulty in isolating this mass it was decided not to do a nephrectomy. A small piece was removed for histological study.

Histological diagnosis was embryonal adenomyosarcoma of the kidney.

The postoperative course was uneventful. It was advised that the patient be given deep X-ray therapy. The child was removed to the Presbyterian Hospital, where fifteen deep X-ray treatments were given by Dr. Cassie Rose.

After the second deep X-ray treatment there was a remarkable reduction in the size of the tumor. The tumor apparently decreased to one-half its original size. After this diminution in size the further treatment had no effect on the tumor and it seemed to remain stationary.

Examination of the patient about one month after institution of the X-ray treatment revealed multiple masses in the abdomen. They increased rapidly in size. Coincident with this sudden increase in size of the abdominal masses a large amount of sugar was found in the patient's urine.

The patient was admitted a third time to the hospital, December 23, 1928.

The patient had an old and emaciated appearance. Arms, thighs and legs were extremely emaciated; ribs, prominent. Superficial veins of the upper abdomen and chest were very prominent. On the right side there was distention of the veins to the umbilicus. In the midline was felt a swelling apart from the rest of the general abdominal distention. The left half of the abdomen was tense and a large nodular mass was felt on the right side of the abdomen. It was hard and extended down to the umbilicus. The impression conveyed was that it was due to a much enlarged liver, the result of metastases. A metastatic nodule was noted in the right testicle.

Urinalysis report was: Cloudy; reaction, acid; albumin +++; sediment, loaded with bacteria; pus, 0; blood, 0, casts, 0.

Blood examination showed: Red blood cells, 2,320,000; white blood cells, 11,600; hemoglobin, 45 per cent.

The patient died December 26, 1928.

Histology of Surgical Specimen.—(H. and E.; phosphotungstic acid hematoxylin): Diffuse epithelial cell nests; loose stroma; solitary new tubules, both inside and outside of cell nests; focal compression necrosis with suppuration; coarse striated muscle fibers in bundles.

Autopsy was performed four hours after death.

Anatomic Diagnosis.—Primary embryonal adenomyosarcoma of the left kidney (Wilms tumor); dilatation of the pelvis of the left

kidney; compression atrophy of the left kidney; multiple metastases to the liver and mesenteric lymph nodes; fibrous peri-splenitis; compression atrophy of the adrenal glands; implantation tumor with obstruction of the left ureter; compression dilatation of the left pampiniform plexus; compression atrophy of the liver; cholesterol deposits of the liver; malnutrition; ascites.

Essential autopsy findings were those of a markedly emaciated white boy, 2½ years old, by actual weight 12⅓ kg., and 97 cm. long; a symmetrical tumor of the left kidney weighing 1,110 grams (Fig. 3), which had arisen within the kidney and by its growth had destroyed the kidney except for a portion of the upper pole; huge metastases into the liver, altogether weighing 2,600 grams, which compressed the liver by its rapid growth and so distorted the shape of the liver that the falciform ligament lay to the left of the midline of the abdomen and the gallbladder in the left upper quadrant of the abdomen.

Histology of Tumor of the Left Kidney.—Loose stroma, epithelial cell nests, some of which contained tubules and others which were epithelial cell nests without tubules, striated muscle fibers in bundles, extensive compression necrosis; left ureter implantation tumor with necrosis; huge metastasis to the liver, which contained epithelial cell nests and tubules, and compression atrophy of the left kidney.

Case 3.—B. R., male, white, aged five years, was admitted to the Children's Memorial Hospital on the service of Dr. Sigurd Kraft, August 19, 1927.

Complaint on entrance was the presence of a large mass in the abdomen. The patient had been irritable for the past twenty-one months. Three weeks before admission the mother noticed the presence of a swelling in the abdomen, which apparently caused no upsets. There had been no loss of weight and urinary symptoms were absent. During the past months there had been attacks of nausea and vomiting.

Physical examination revealed a thin and undernourished child but not acutely ill and not in distress. Tonsils were slightly enlarged and reddened. Heart and lungs were negative.

There was a large mass in the upper left quadrant of the abdomen which extended 1.5 inches to the right of the midline and well down into the lower left quadrant. The mass was smooth, rather firm in consistency, not tender, and moved with respiration. The edges were well defined. Upon palpation it was evident that this tumor sprang from the left kidney.

Examination of external genitalia was negative.

Temperature was 99 degrees.

Blood examination showed: Red blood cells, 3,890,000; white blood cells, 9,600; hemoglobin, 70 per cent; polymorphonuclear

neutrophiles, 75 per cent; lymphocytes, 24 per cent; transitionals, 1 per cent.

Von Pirquet test was negative.

Urinalysis report was: Reaction, acid; albumin, 0; sugar, 0; sediment, few hyalin and granular casts; occasional red blood cells; occasional white blood cell.

Roentgen-ray examination of the chest was negative; abdomen—a circular opaque shadow occupied the left upper quadrant and extended over to the right side beyond the midline.

Preoperative diagnosis was malignant tumor of the left kidney.

Operation was performed August 22, 1927, under ether anesthesia (Dr. E. M. M.). The usual kidney incision was made. Tumor, exceedingly friable, was removed, and the vessels ligated. The wound closed with drainage.

Histological diagnosis was sarcoma—multiple cell type—of left kidney.

Postoperative course was uneventful. The patient received six deep X-ray treatments and was discharged from the hospital October 4, 1927. Examination before the child left the hospital revealed the presence of a large recurring tumor.

The patient died, April 13, 1928.

Description of Surgical Specimen.—The kidney and multiple surgically excised portions of tumor tissue together weighed 450 grams. The surgically excised portions varied from 2 to 30 grams in weight; they were soft, friable, occasionally smooth, compressible and dark brown.

The tumor was sharply defined to its attached kidney, from which it arose in the back portion of the lower pole.

Histology.—Between the tumor and the kidney itself there was a fibrous tissue layer. The kidney itself was normal except for compression where it was adjacent to the tumor and here the kidney intertubular tissue was increased and fibrous. The tubules were irregular in size and shape and had large nuclei which stained deep with hematoxylin because of the coarse granules. Some of the kidney tubules contained leukocytes, both polymorphonuclears and lymphocytes, but in the fibrous band between the kidney and tumor itself there was an infiltration also of polymorphonuclear leukocytes and lymphocytes. Deeper into the tumor was a loose stroma network (Fig. 15) containing multiple new tubules which were usually small and round, but some of them had folded walls to produce a papillary structure. Epithelial cells were scattered throughout but there were no real epithelial cell nests here. Elsewhere in the tumor the stroma was infiltrated with large pale stained epithelial cells with nuclei which contained fine granules. These cells were evenly scattered throughout the stroma and although they did not occur in true epithelial cell nests they were present in compact clumps.

Throughout the tumor there were strands of smooth muscle but no definite striated muscle was present.

Case 4.—W. W., male, white, aged five months, was admitted to the Children's Memorial Hospital on the service of Dr. Joseph Brennemann, August 24, 1923.

One month before admission to the hospital the mother noticed a swelling on the left side of the abdomen just below the costal margin. When first discovered the tumor was about 3 or 4 inches in diameter, but it rapidly grew larger, and at the time of admission filled the entire left side of the abdomen, causing a marked bulging. The mother had noticed no loss in weight, no constipation, and there were no urinary symptoms.

Physical examination revealed a well-nourished white infant, playful and smiling. Heart and lungs were negative.

A rounded, bulging tumor mass filled the entire left half of the abdomen and bulged into the flanks. The skin was tightly stretched over the mass and was shiny. The mass was firm in consistency, a little more prominent in front to the left of the navel for about 2 inches. On palpation, the mass could be outlined along the midline midway down in the left lower quadrant and the upper limits were lost under the arch of the ribs. The circumference of the abdomen at this point was 18.5 inches.

Examination of the genitalia revealed that the testicles were not in the scrotum.

Temperature was 99.2 degrees on admission.

Blood examination showed: Red blood cells, 3,100,000; white blood cells, 26,200; hemoglobin, 55 per cent; polymorphonuclear neutrophiles, 46 per cent; small lymphocytes, 44 per cent; large lymphocytes, 4 per cent; large mononuclears, 1 per cent; transitionals, 2 per cent; eosinophiles, 3 per cent.

Urinalysis report was: Clear; reaction, acid; albumin, 0; sugar, 0; blood, 0.

Von Pirquet test was negative.

Roentgen-ray examination of the abdomen showed all shadows to be obscured by a large opaque shadow occupying the entire left abdomen.

Operation was performed August 30, 1923, under ether anesthesia (Dr. A. F. M.). Exploratory operation only was done.

The child died, August 31, 1923.

Autopsy was performed three hours after death.

Anatomic Diagnosis.—"Bilateral" embryonal adenomyosarcoma (huge of the left kidney and slight of the right kidney); abdominal viscera displaced to the right; pressure atrophy and partial hydronephrosis of the left kidney; recent surgical abdominal exploratory operation wound; generalized anemia; hyperplasia of the thymus, spleen, and lymphoid tissue of the lining of the bowel; hypostatic

hyperemia and edema of the lungs; slight hypostatic bronchoneumonia; cloudy swelling of the liver and right kidney; fatty changes of the liver and right kidney; dry and crusted lips; unequal pupils; undescended testicles; partial congenital sinus of the right ureter; accessory spleen.

The essential autopsy findings were those of a five months old boy, weight 12.5 pounds, measurement 62.5 cm. long; a huge, solid tumor in the left kidney which weighed 545 grams and displaced the abdominal viscera to the right; a second tumor of the lower pole of the right kidney which was pale gray, sharply defined in sharp contrast to the adjacent compressed kidney. Other than the huge tumor of the left kdiney and the small tumor of the right kidney there was no evidence of metastasis anywhere in the body.

Histology of the Kidney Tumors.—Dense epithelial cell nests; rather dense epithelial stroma, tubules both in epithelial cell nests and solitary out in the loose stroma, the tubules were sharply defined and were quite like those of a normal kidney; compression atrophy of the kidney; center liquefaction necrosis; dense masses of sharply defined striated and non-strated muscle fibers.

Case 5.—R. F., female, white, aged five years, was admitted to the Children's Memorial Hospital on the service of Dr. S. J. Walker, December 22, 1914.

Four months before admission to the hospital, that is, when the child was about four and a half years old, it is alleged that the child ran along the top of a wall, when she fell to the ground, striking her abdomen against the wall, after which the mother noticed a small, hard lump a little larger than a hen's egg in the abdomen. Two days after the injury the child vomited a good deal. Subsequently a large hard swelling developed in the abdomen which increased rapidly in size. The child was constipated and bowel movements were painful. There had been no urinary symptoms; no history of blood in the urine or feces. During the two years before admission, the child had lost some weight. There was pain in the abdomen which was most marked in the left side, and the pain was worse at night.

Physical examination revealed a rather poorly nourished but well-developed child, able to walk about the ward with comfort. The skin had a sallow-tan color. Teeth were in poor condition. The heart was normal except for a systolic murmur. Lungs were negative.

The abdomen showed marked enlargement due to a tumor mass. Veins over the entire abdomen were large. The suprapubic region and the lower right iliac region were the only places free from this mass. In the right upper quadrant there was felt an oval mass about the size of a fetal head, approximately 10x10 cm. This

mass had a cystic feel and was surrounded by an area of comparative tympany. The mass moved partly with respiration. There were a few enlarged antero-posterior cervical and submaxillary lymph glands, as well as a few palpable inguinal glands. The veins of the extremities were prominent.

Temperature was 101 degrees on admission.

Blood examination showed: Red blood cells, 4,160,000; white blood cells, 8,200; hemoglobin, 80 per cent. Stained blood smears were negative.

Blood Wassermann was negative.

Urinalysis report was: Reaction, acid; albumin, +; sugar, 0; sediment, few white blood cells and few hyalin casts.

Phthalein test, thirty per cent secretion in two hours.

Cystoscopic examination of the bladder was negative. Ureteral catheter on the left side met an obstruction. Three catheters were passed into the ureter for about ¾-inch, beyond which point catheters could not be advanced. A pyelogram was attempted through this catheter but the fluid failed to reach the kidney.

Preoperative diagnosis was malignant tumor of the kidney.

Operation was performed January 7, 1915, under general anesthesia (Dr. B.). A right nephrectomy was done.

The child died, January 28, 1915.

Histology of the Surgical Specimen.—The kidney and its adherent tumor together weighed 265 grams. It was essentially of uniform, globoid shape with lobules elevating the surface capsule. The tumor arose centrally in the kidney and by its growth pushed the normal kidney outward. The kidney tissue which remained was sharply defined, definitely separated from the tumor and the kidney was so compressed in places that it was only 3 to 4 mm. thick. The tumor itself consisted of lobules 5 to 20 mm. in diameter, which were gray to pink, firm, of even consistency throughout. The lobules were separated from each other by fibrous bands, and in several of these lobules there were dark red to black, soft, friable portions 1 to 3 cm. in general diameter.

Histology.—Dense epithelial cell nests with large nuclei which were coarsely granular; the epithelial cell nests had isolated tubules in their centers and elsewhere the central walls of the epithelial cell nests were clumped or agglutinated together as in the formation of new tubules. Fibrous bands ramified throughout the tissue. Single strands of striated muscle fibers were present throughout the diffuse loose stroma.

Case 6.—W. A., male, white, aged three months, was admitted to the Children's Memorial Hospital on the service of Drs. Buford and Walker, July 1, 1915.

For a period of six days previous to admittance the patient had

suffered anorexia, vomiting, crying, fever and constipation. He had always slept well until the night before admission to the hospital; apparently in a good deal of pain most of the time. There were no convulsions; no urinary symptoms. He had vomited every day since the onset of the illness up to and including the day of admission to the hospital.

Physical examination revealed a rather poorly nourished child, crying a good deal. The entire surface of the body was covered with a fine petechial rash. Heart and lungs were negative.

Very prominent superficial veins covered the abdomen, which

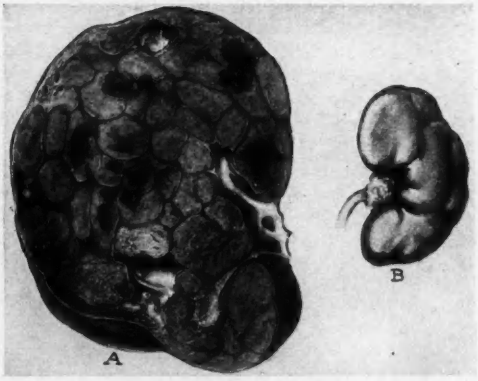

Fig. 4. Case 6. *A*, Note the irregular lobulations and areas of necrosis; *B*, and the size of tumor compared with the normal opposite kidney.

was rigid; a large tumor mass palpated on the right side. The mass was round in outline, hard in consistency and well defined, extending from beneath the costal arch into the inguinal region and into the midline as far as the umbilicus.

Through rectal examination the lower pole of the tumor mass was felt extending to the right side of the pelvis.

During the time in the hospital, the highest temperature was 99.2 degrees, and this occurred only once; twice there was a temperature of 99 degrees.

Blood examination showed: White blood cells, 28,650; polymorphonuclear neutrophiles, 46 per cent; small lymphocytes, 54 per cent.

Blood Wassermann was negative. Father's and mother's Wassermann tests were negative.

Von Pirquet test was negative.

Urinalysis report was: Turbid; reaction, acid; albumin, +; sugar, 0; sediment, 0.

Phthalein test showed only the slightest trace of dye at the end of a two-hour period of collection.

Roentgen-ray examination of the abdomen after bismuth feeding revealed that the stomach was displaced to the left; most of the intestines were in the left side of the abdomen. Liver and tumor occupied the whole right side as evidenced by a shadow that extended from the fifth rib into the groin.

The child died, July 13, 1915. (No operation.)

Autopsy. (Incision of the abdomen only was allowed.) The body was that of a moderately emaciated white boy 18 inches long. There was a marked protuberance of the upper right quadrant of the abdomen. Here there was a large, hard, irregular mass which extended from the costal arch above to the right anterior iliac spine and to a little left of the midline of the abdomen. The mass was lobulated and slightly movable.

On opening the abdomen in the region of the tumor there was a lobulated mass the size of the patient's double fist, occupying the right kidney region. Across the lower median pole there was a loop of small bowel, but this was not adherent to the tumor mass. On opening the fibrous capsule of the mass, the tumor was easily shelled out. The right adrenal gland was in normal position and was not enlarged. The right ureter was twice as large as the left, but its pelvis was not distended. On passing a fine probe from the bladder in the right ureter, an obstruction was met a short distance from the bladder. The left ureter was patent. The left kidney had a dime-sized subcapsular hemorrhage. The surfaces made by section were hyperemic and were without pathologic change. The left adrenal was like the right in all essentials. The lining of the urinary bladder was enlarged.

On section of the tumor mass there were many soft lobulations from which a pink fluid was expressed. These friable masses were in a general arrangement which corresponded to the markings of a kidney, but only slightly so. Beneath the capsule a thin structure surrounding the entire mass resembled somewhat the cortex. There were a few cavities throughout the mass which contained pink-yellow semi-fluid. The liver, spleen and gastro-intestinal tract were unchanged.

Anatomic diagnosis was sarcoma of the right kidney; occlusion of the right ureter.

The preserved right kidney mass weighed 295 grams; the left kidney, 13 grams (Fig. 4). The left kidney was normal in all essentials. The right kidney mass measured 11x7x8 cm. It was everywhere encapsulated; its surface was irregular due to nodulations 1 to 3 cm. in general diameter as measured on the surface. On six surfaces made by cutting, at least nine-tenths of

the entire mass was of tumor tissue. These surfaces were uniformly smooth, glistening, and uniformly firm. These surfaces consisted of single nodules 5x8 mm. in general diameter to conglomerate masses 3 to 3.5 cm. in diameter. These conglomerate masses were largely of the upper pole. An irregular mass of the lower pole about 3 cm. across was dark brown, glistening, lobulated and had a suggestion of striations of the cortex and pyramidal portion. It cut with the consistency of the normal kidney. It was the only structure which grossly resembled what was left of this kidney tissue. The tissue between the light brown to gray fibrous-like tumor nodulations was soft, friable, dark brown and brown-black stippling, as in old blood exudation. On close inspection this inter-nodulation tissue resembled compressed kidney tissue. All sections made by cutting were similar. The pelvis of this right kidney and tumor mass was not a single sac, but rather consisted of irregularly dilated sacculations, some of which were 1 cm. in circumference. These sacculations were normally thin-walled, had glistening linings and these were irregularly fused to converge at the ureter, which was 3 mm. in circumference and resembled the left ureter in all essentials grossly. In the lower pole, between the kidney tissue and the tumor tissue, three sacculations of this pelvis measured 3 to 10 mm. long and 2 to 5 wide. These were the only places where the pelvis was distended.

Histology.—Large clumps of loosely packed epithelial cells in fibrous reticulum. New tubules were abundantly present in the peripheries of the epithelial cell masses. The tubules were of irregular shape and in general were larger than a normal tubule; they were sharply defined. Tubules were present both within the cell nest and occurred out in the loose stroma in such huge number that thirty-six could be counted in a single low power field. Elsewhere there were clumps of large epithelial cells which had a clumping together in their central portions as in the formation of new tubules. Single strands of striated muscle fibers were present, but thick bundles of non-striated were abundant. There was diffuse compression anemic necrosis with focal suppuration.

Case 7.—F. O., male, white, aged six and one-half years, was admitted to the Children's Memorial Hospital on the service of Dr. Gustav Kaufmann, March 10, 1919.

Two weeks before admission the patient suddenly complained of severe pain in the right side of abdomen following a bowel movement. Nausea and vomiting followed and temperature rose to 103 degrees. The temperature, nausea and vomiting persisted for several days.

Physical examination revealed a decidedly anemic child who appeared to be in great pain. Pupils reacted to light; teeth were in

poor condition; tongue, very red; tonsils enlarged and reddened; neck, moderate lymphadenopathy; chest, marked rachitic rosary; heart, roughened first sound, heard at the apex, transmitted to the axilla and toward the base. Lungs were negative.

There was a bulging tumor mass in the right upper quadrant of the abdomen. It extended just a little beyond the midline and about one-third of the distance between the costal arch and the crest of the ilium and did not move with respiration. A peculiar crepitant sensation was elicited upon palpation. The records stated that this was like a subcutaneous emphysema.

Temperature on admission was 103 degrees and came down to normal in seventy-two hours. Following the operation, temperature rose to 104.5 degrees.

Blood examination showed: Red blood cells, 2,650,000; white blood cells, 22,700; polymorphonuclear neutrophiles, 85 per cent; small lymphocytes, 4 per cent; large lymphocytes, 4 per cent; transitionals, 3 per cent; myelocytes, 4 per cent.

Urinalysis report was: Reaction, acid; albumin, +; sediment, white blood cells. Many urinalyses showed the presence of albumin, but no casts.

Roentgen-ray examination of the colon by air inflation showed the ascending and transverse colon above the tumor mass. Previously felt crepitation had disappeared.

Operation was performed March 13, 1919, under ether anesthesia (Dr. B.). Exploratory laparotomy in the midline was done. Peritoneal cavity, negative. A large retroperitoneal tumor mass was found in the right kidney area. Abdominal incision was closed and right posterior incision made. A nephrectomy was done.

Postoperative course was complicated by diphtheria and measles. Examination by Dr. H. Helmholz, May 15, 1919, revealed the presence of a palpable mass in the right kidney region. The patient developed a bronchopenumonia on May 19, 1919. Great abdominal distention developed, May 28, 1919. The patient was taken away from the hospital, May 28, 1919, against advice. He was cyanotic; respiration was labored; abdomen greatly distended; signs of fluid in the abdominal cavity.

Death occurred four days after the patient was taken home.

Histology of the Surgical Specimen.—The kidney and its attached tumor together weighed 165 grams. The tumor arose centrally within the kidney and pushed the kidney tissue outward with compression of its opposite poles. The kidney tissue present was dark brown and sharply demarcated from the light gray-pink tumor tissue. The tumor was of uniform consistency, soft, compressible, except for soft, friable, porous places which were dark red to black.

Histology.—The kidney was normal except for tubular degeneration. Between the kidney and tumor was a fibrous reticulum con-

taining lymphocytes, then a dense cell mass of small epithelial cells and leukocytes, and the next layer was a pale stained, necrotic mass of tissue which stained with eosinophile only, except for isolated leukocytes, which were blue with hematoxylin. The tumor itself consisted of dense epithelial cell nests and loose cell masses of epithelial cells with isolated tubules in the cell nests and in places there was an agglutination of cells in the central portions of the epithelial cell nests forming tubules. Between lobules there were masses of tissue of compression anemic necrosis, portions of which contained disintegrated leukocytes.

Fig. 5. Case 8. Areas of necrosis in the center of the tumor, which is surrounded by a capsule. The tumor has displaced over one-half of the kidney. Note the sharp line of demarcation between the kidney and the tumor.

Case 8.—R. W., male, aged two and a half years, was admitted to the Presbyterian Hospital on the service of Dr. C. G. Grulee, January 5, 1925.

The patient on admittance had a mass in the abdomen. Six weeks previous while the child was standing up the mother noticed the presence of a swelling the size of an orange in the left upper quadrant. This mass had gradually increased in size, growing toward the midline. For the past six months the patient had had difficulty passing his urine in that it was necessary for him to strain considerably at each urination, but pain was absent. He voided several times a day in large amounts; no blood in the urine at any time. He had slept well and there had been no loss in weight.

Physical examination (Dr. C. G. Grulee) revealed a well-developed and well-nourished child. Head and neck were negative with the exception of slightly enlarged tonsils. A few enlarged, shotty glands were felt in the posterior triangles in the neck. There was slight dullness in the left lower lobe of the lungs posteriorly and the excursion of the diaphragm was limited.

A mass could be felt in the left upper quadrant of the abdomen extending well below the umbilicus below and 2.5 inches beyond the midline to the right. The tumor was firm and smooth except for an apparent lobulation above the midline.

Examination of the external genitalia was negative; extremities, negative.

Blood examination showed: Red blood cells, 4,280,000; white blood cells, 6,800; hemoglobin, 85 per cent.

Urinalysis report was: Reaction, acid; albumin, 0; sugar, 0; blood, 0; bile, 0; sediment, 0.

Cystoscopic examination revealed a normal bladder. Ureters were normal and catheterized without difficulty or obstruction. Urines from the right and left kidneys and bladder were sterile and free of pus. Using Indigo carmin, a concentrated discharge of blue urine from the right side was obtained in ten minutes and a very dilute, pale blue urine from the left side in fifteen minutes.

Roentgen-ray examination showed a dense shadow involving the greater part of the left side of the abdomen.

Left pyelogram was normal.

In spite of the fact that the left pyelogram was normal a diagnosis of malignant tumor of the left kidney was made and operation advised.

Operation was performed January 12, 1925, under ethylene anesthesia (Dr. H. L. K.). Through the usual oblique kidney incision a left nephrectomy was done.

There was an uneventful recovery and the patient was discharged, January 30, 1925.

Histology of Surgical Specimen.—The entire kidney mass weighed 294 grams (Fig. 5). In general it was pear-shaped, the stem portion consisting of grossly normal kidney, the base of which flattened out broadly into the huge tumor mass, from which the kidney was separated by fibrous bands. Approximately one-third to one-half of this original kidney was present. Its cortex was easily 2 to 3 mm. wide. Its striations were normally present in relation to the medullary portion.

The entire mass was normally encapsulated. This capsule readily stripped off from the kidney proper, but where the kidney was flattened out to blend into the broad tumor mass, the capsule was rather firmly adherent and took fine shreds of tumor tissue with it when separation of the capsule and the tumor was attempted. After re-

moval of the capsule, however, the general surface was essentially smooth and light gray to light brown, in sharp contrast to the adjacent dark brown kidney tissue.

On surfaces made by cutting, about four-fifth of the tumor mass was rather firm and in places friable. It was light gray to brown and of essentially equal consistency, centrally as peripherally. The remaining one-fifth, which was of the lower pole, was soft and mushy; it was lighter gray and putty-like in consistency. Here pressure necrosis was definite.

Histology.—Dense epithelial cell nests with large, coarsely granular nuclei which were vacuolated. The nests contained huge, well-formed tubules, some of which were in the process of formation. The nests were separated by fibrous tissue strands and in some of these nests there were masses of disintegrated leukocytes. Tubules were abundant; masses of pale stained, epithelial, cellular stroma of compression necrosis; many non-striated muscle fibers; solitary single strands of striated muscle fibers; dense fibrous stroma in which were scattered large epithelial cells with coarsely granular evacuolated nuclei.

Case 9.—B. B., male, white, aged nineteen months, was admitted to the Children's Memorial Hospital on the service of Dr. Charles Schott, November 13, 1924.

The patient had a large mass in the abdomen. To the father's knowledge, the child had been perfectly well until about two months before admission, when he became very nervous, developed a poor appetite and did not appear to be well. He also began to lean forward when urinating. He was taken to a physician who advised circumcision, and this was done. A week following the circumcision, or four weeks before admission to the hospital, the mother found a mass in the left side of the abdomen. There were no urinary symptoms. The child had had some fever off and on since the circumcision.

Physical examination (Dr. C. Schott) revealed a fairly well-developed, rather poorly nourished child who did not appear acutely ill. The chest was moderately emaciated; slight Harrison's groove and rachitic rosary. Lungs and heart were negative.

Examination of the abdomen showed a bulging of the left flank. A very large, hard tumor mass filled the whole left flank and the whole abdomen to the left of a line about 1 cm. to the right of the left nipple. The mass was regular except a protuberant portion about 1 inch above the umbilicus which extended from the tumor mass proper to the midline of the abdomen. It was hard and attached to the main tumor, about 2 cm. across. It was possible to palpate between the tumor and costal margin from the anterior axillary line to the right. The mass was not tender; no discoloration of the skin. Liver and spleen were not felt.

Examination of the external genitalia was negative.

A second examination by Drs. Schott and Brennemann verified these findings.

Through rectal examination a tumor mass was palpable extending down into the pelvis. The lower pole was smooth, rounded and not tender.

Colon inflation revealed the colon passing over the tumor mass.

Temperature on admission was 99 degrees and never went higher.

Blood examination showed: White blood cells, 6,200; hemoglobin, 75 per cent.

Nasal and throat cultures were negative.

Fluoroscopic examination with barium verified the previous colon examination.

Roentgen-ray examination of the chest was negative for evidence of metastasis. Examination of the abdomen, following barium enema, showed a filling defect in the descending colon, accounted for by intra-abdominal pressure.

Preoperative diagnosis was sarcoma of the left kidney and operation was advised.

Operation was performed November 21, 1924, under ether anesthesia (Dr. E. M. M.). Nephrectomy was carried out. The patient died on the table.

Autopsy examination was made through the surgical wound only.

Anatomic Diagnosis.—Mixed cell tumor of the left kidney; recent surgical left nephrectomy operation wound; abdominal content displaced to the right; acute anemia; emaciation; hypodermic needle puncture wounds. The organs were all found to be grossly normal and nowhere were there any metastases present either in the lungs or abdominal cavity.

The right kidney was normal in every respect and weighed 68 grams. The surgically removed left kidney and its adherent tumor together weighed 675 grams. The tumor arose centrally and compressed the kidney outward so that the kidney itself was sharply defined from the tumor mass, from which it was separated by fibrous bands and was essentially a node of kidney tissue, the main portion of which measured about 2 x 3 x 1.5 cm. and thinned out to newspaper thickness at the tumor margin. The tumor itself was firm to hard, of uniform consistency throughout. When cut across in several places it was lobulated in places 2 to 3 cm. in diameter which were gray to pink and some of these lobules contained dark red to black, soft, friable places.

Histology.—Loose stroma hugely infiltrated with epithelial cells in an even arrangement, but in portions of the sections larger epithelial cells were arranged in nests containing indistinct, partially formed, new tubules. Throughout the epithelial stroma there were solitary

fibers of striated muscle. In multiple places there were compression necrosis and masses of disintegrated leukocytes and debris.

Case 10.—L. J. W., female, white, aged thirteen months, was admitted to the Children's Memorial Hospital on the service of Dr. Joseph Brennemann, October 8, 1928.

The parents stated that the baby had always had a very large, prominent abdomen and that this had been noticed since she was about one month old. They did not attach importance to this enlargement until the baby was thirteen months old, when they took her to a doctor because it was their impression that the abdomen was growing larger than the rest of the body. The doctor made light of the mother's story and expressed the opinion that the baby would outgrow the condition. Another doctor was consulted and a diagnosis of tumor of the kidney or enlarged spleen was made. On several occasions the mother noted blood in the bowel movement. There were no urinary symptoms.

Physical examination by Dr. J. Brennemann revealed a well-nourished child with a strikingly large abdomen. The tonsils were enlarged.

A large mass on the left side of the abdomen which was firm, movable and not nodular, occupying practically the whole of the left side of the abdomen, extended well back into the flanks. There was a small tubular mass just to the left of the navel above the other mass.

Blood examination showed: Red blood cells, 6,330,000; white blood cells, 14,840; hemoglobin, 60 per cent; polymorphonuclear neutrophiles, 30 per cent; lymphocytes, 66 per cent; eosinophiles, 4 per cent.

Urinalysis report was: Reaction, acid; albumin, +; sugar, 0; sediment, much amorphous material.

Fluoroscopic examination with barium meal showed the intestines to be anterior to the mass and very close to the abdominal wall.

Roentgen-ray examination of the chest revealed no evidence of metastasis.

Cystoscopic examination of the bladder was normal. Both ureters were catheterized without difficulty or obstruction. Urine from the right kidney was normal; no urine obtained from the left side.

Right pyelograms were normal. On the left side, the bromide solution met an obstruction at the ureteropelvic junction, hence no pyelogram was obtained. There was a filling defect due to the tumor.

Pre-operative diagnosis was malignant tumor of the left kidney.

Operation was performed October 18, 1928, under ether anesthesia (Dr. H. L. K.). The usual oblique kidney incision was made, and the tumor delivered through the wound, the ureter being clamped and divided. The renal pedicle was clamped and ligated. The usual wound repair was made (Fig. 6).

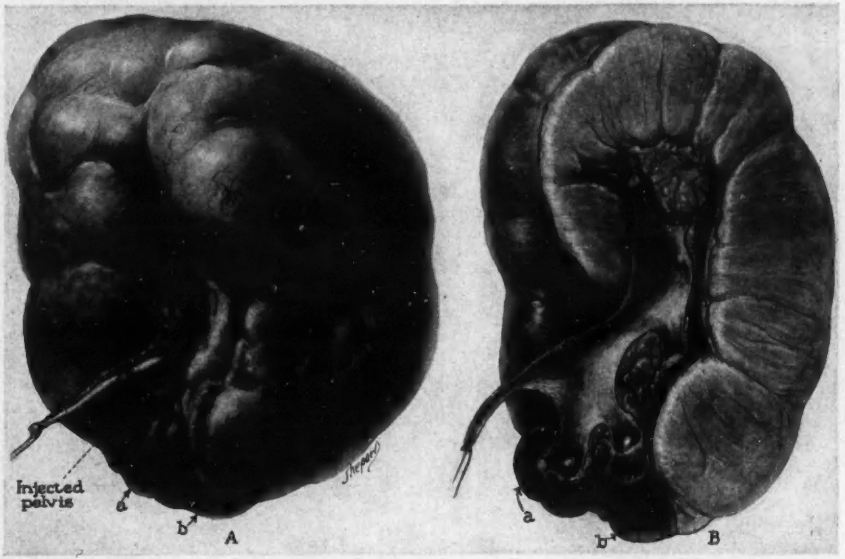

Fig. 6. Case 10. *A*, Specimen removed at operation showing general rounded outline of the tumor with irregular surfaces. Pelvis has been distended with salt solution; is about normal in size. *B*, Specimen open; *a*, small remnant of kidney tissue; *b*, area of necrosis. There has not been much encroachment upon the kidney pelvis by the tumor.

The postoperative course was uneventful.

Since leaving the hospital the patient has had two courses of deep X-ray treatment. Examination showed no sign of recurrence. A recent examination, November 12, 1929, showed no sign of recurrence and the patient was perfectly well one and a half years after nephrectomy (April, 1929).

Histology of Surgical Specimen.—The kidney and its adherent tumor together weighed 785 grams. Only a small portion of the kidney remained which had not been obliterated by compression. The tumor itself was of uniform, firm consistency; in general it was semi-spherical, about the size of a grapefruit. When cut across it was firm to hard, of even consistency throughout. It was easily shredded and generally gray tinged with pink.

Histology of Kidney Tumor.—Marked compression atrophy with extensive tubular degeneration; diffuse epithelial cell stroma with clumps of epithelial cells of nest-like structure; the nuclei of the epithelial cell nests stained deeply, but the epithelial cells in the stroma had large nuclei which were finely granular and contained vacuoles. Elsewhere throughout the tumor tissue the epithelial nests were abundant, were compact, together, and in their central portions retained many new tubules. Adjacent to isolated cell nests there were striated muscle fibers usually in single strands.

Case 11.—A. G., male, aged six years, was admitted to the Children's Memorial Hospital on the service of Dr. A. H. Montgomery, April 28, 1921.

A swelling in the abdomen was present. Two months before admission to the hospital the patient had fallen, striking his left side against a bench. Pain was present in the side for about a fortnight and then disappeared. Pain recurred in the left side three days before the patient entered the hospital, at which time a very large swelling was noted. A doctor was called and found the presence of a large left upper quadrant tumor. He aspirated the stomach but no pus or fluid was obtained. Appetite was good; bowels, normal; urination normal.

Physical examination revealed a fairly well-developed and well-nourished child. Head, neck, nose, throat, heart and lungs were negative.

A very large, firm tumor was found in the left upper quadrant, extending into the right half of the abdomen in the region of the umbilicus down to within 1 cm. of the crest of the ilium on the left. The tumor was movable, had definite borders, and a notch could be felt along the superior surface. There was no tenderness on palpation.

Blood examination showed: Red blood cells, 4,200,000; white blood cells, 12,200; hemoglobin, 80 per cent.

Urinalysis report was: Reaction, acid; albumin, 0; sugar, 0; casts, 0; leukocytes, 0.

Roentgen-ray examination revealed a very large tumor mass extending from the region of the left kidney, beyond the midline and down into the iliac fossa.

Examination of the abdomen (Dr. H. L. K.) revealed a large, hard, irregular, movable tumor which extended beyond the umbilicus. A notch could be felt. The lower edge was smooth and hard.

Pre-operative diagnosis was sarcoma of the left kidney.

Operation was performed by Dr. A. H. Montgomery, May 19, 1921, under ether anesthesia. Exploratory laparotomy performed, a section was removed for histological study, and the wound was closed.

The patient left the hospital on June 11, 1921; condition unchanged. Death followed soon afterward.

Histology.—Fibrous tissue stroma containing isolated epithelial cell nests in which were new tubules. Isolated tubules were also present out in the loose stroma.

Case 12.—J. B., male, white, aged one year, was admitted to the Presbyterian Hospital on the service of Dr. H. L. Kretschmer, July 17, 1929.

There was enlargement of the abdomen and a tumor mass on the right side. Six weeks before admission to the hospital the mother was bathing the child and asked her mother-in-law if the child's abdomen wasn't too large. The mother-in-law felt the abdomen and noticed a very hard, nodular mass in the right hypochondrium. The mass was not painful and had increased very slowly until two weeks before admission, when the growth was rapid, extending from the costal margin to the crest of the ilium. There were no urinary symptoms; no blood in the urine.

Physical examination revealed a fairly well-developed and well-nourished child. Head, neck, heart and lungs were negative.

A large tumor in the right upper quadrant of the abdomen extended from the arch of the rib down to the crest of the ilium and two fingersbreadth beyond the left of the umbilicus. The mass was firm, smooth, elastic and freely movable; the borders were easily palpable.

Blood examination showed: Red blood cells, 4,000,000; white blood cells, 16,200; hemoglobin, 68 per cent.

Wassermann and Kahn tests were negative.

Blood chemistry, examination before operation showed: Urea nitrogen, 23.4; uric acid, 5.0; creatinin, 22; total non-protein nitrogen, 41.7. Four days after operation—Urea nitrogen, 100; uric acid, 9.1; creatinin, 4.3; total non-protein nitrogen, 126.9.

Urinalysis report was: Reaction, acid; sugar, 0; albumin +; blood, 0; red blood cells, rare; leukocytes, rare.

Roentgen-ray examination revealed a uniform dense shadow over the right half of the abdomen.

Cystoscopic examination of the bladder was normal; ureters catheterized without difficulty or obstruction.

Left pyelogram was normal. The right ureter was displaced to the left side of the abdomen, the malposition beyond the midline being apparently due to the large tumor. No fluid entered the right kidney pelvis.

Fluoroscopic examination with barium meal showed the right half of the colon to be displaced to the midline.

Operation was performed July 21, 1929, under ether anesthesia (Dr. H. L. K.). A right nephrectomy was done.

The right kidney after excision weighed 514 grams (Fig. 7). It was encapsulated and in general was of kidney shape. Its surface generally was smooth. On seven transverse sections made by cutting, the surfaces were about one-half of them light gray, and the other half dark red to brown. The light gray portions consisted of tumor nodules, the largest of which measured 32 cm. in diameter. These nodules were of even consistency centrally and peripherally; they were firm to hard and in sharp contrast to the adjacent light brown compressed kidney tissue remnants. This kidney tissue had a suggestion of cortex with striations and a few definite pyramids. The nodules were conglomerate but each nodule was separated from its neighbor by a firm, fibrous tissue band. In the lower pole, where the mass was broadest, adjacent to the light gray nodules, there was dark red to brown, soft, friable tissue resembling compressed necrotic kidney tissue. Portions of compressed pyramids were definite, and from these places delicate, compressed bands of this kidney tissue extended out into the tumor mass between the nodules of tumor tissue, which here were firm and pearl-gray. All the tumor tissue in the left kidney was grossly identical.

Histology of Surgical Specimen.—Loose stroma; widely surrounding epithelial cell nests; new tubules, both in epithelial cell nests and in loose tissue; stroma bundle present; isolated striated muscle fibers.

Following the operation the child developed complete anuria. The left kidney was enlarged and tender. An indwelling ureteral catheter was left in place for twenty-four hours. A prompt flow of urine was obtained. Following the removal of the ureteral catheter the patient again developed anuria and the left kidney again increased in size.

Blood chemistry examination at this time showed 133 mg. of urea nitrogen.

A second operation was performed July 29, 1929 (Dr. H. L. K.).

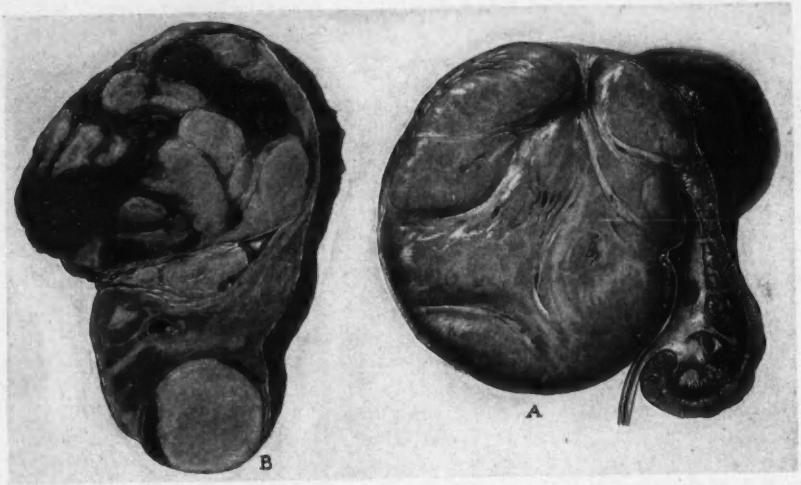

Fig. 7. Case 12. *A*, Specimen removed at first operation. Sharp line of demarcation of tumor. *B*, Specimen of remaining kidney removed at autopsy.

Pyelotomy and decapsulation were done. *The kidney was pale, slightly enlarged and free of tumor.* Following the operation the urinary secretion started immediately, and six days later the urea nitrogen dropped from 133 mg. to 29.1. The child made an uneventful recovery and was discharged, August 20, 1929, twenty-two days after the decapsulation and pyelotomy.

The patient was admitted to the hospital a second time, September 23, 1929. Two weeks prior to this admission the presence of a tumor mass in the left upper quadrant was discovered by the parents. One week prior to admission all of the urine was passed through a fistulous opening in the loin and no urine was passed through the urethra.

Examination of the abdomen revealed a fistulous opening in the nephrectomy scar and the presence of a mass the size of a small grapefruit in the left upper quadrant.

A third operation was performed September 24, 1929, under ether anesthesia (H. L. K.). An incision through the old scar was carried down through the skin and abdominal muscles. A large tumor involving the remaining kidney was found. It consisted of two or three independent masses that were irregular, exceedingly hard and resembled in their gross appearance the tumor that was found on the opposite side.

The sections removed showed adenomyosarcoma.

The patient left the hospital, October 18, 1929, and was given eleven deep X-ray treatments. The child failed rapidly and died, December 22, 1929.

Résumé.—The patient had a bilateral Wilms' tumor. Interesting is the rapidity with which it developed in the remaining kidney, which had been operated upon July 29, 1929, because of anuria, though at the time there was no indication of a tumor. At the third operation, however, September 24, 1929, a large Wilms' tumor involving the remaining kidney was found, its development covering only about six weeks.

Autopsy revealed a huge extension of tumor tissue filling cavity of surgically removed kidney with extensive infiltration into the liver and left kidney; multiple tumor nodule metastases to the lungs; extensive tumor infiltration of all the loose peritoneal tissues; tumor compression of the pancreas.

The left kidney weighed 470 grams (Fig. 7), and was, at least nine-tenths of it, replaced by new tumor tissue which was smooth, homogeneous, gray to light brown, firm to hard; kidney tissue which was present was dark red-brown; left kidney was definitely involved by infiltration rather than by origination of the tumor in the left kidney and subsequent compression of the kidney.

Histology of Left Kidney.—Diffuse compression atrophy and tubular degeneration; compression necrosis; loose stroma containing epithelial cell nests, most of which contained single new tubules or clump of tubules; tubules were present both inside of nests and out in loose stroma; isolated striated muscle fibers were present; the loose stroma adjacent to the kidney retained tubules but no epithelial cell nests were present here; the epithelial cell stroma contained large, pale nuclei and in places here the stroma contained only small nests and only partially developed tubules. Throughout the tumor there were strands of fibrous reticulum with clumpts of lymphocytes. Elsewhere there was diffuse compression necrosis.

The liver showed extensive tumor infiltration of loose epithelial stroma; epithelial cell nests and abundant sharply defined, new tubules and isolated striated muscle fibers.

In the lung the nodules consisted essentially of loose epithelial cell stroma and small clumps of cells in a circular arrangement. The cells invaginated in folds, which were apparently attempts at tubular formation.

Case 13.—G. F., male, white, aged five years, was admitted to the Presbyterian Hospital on the service of Dr. H. L. Kretschmer, April 28, 1924.

Previous history was negative.

There was a large swelling in the left side of the abdomen. The nurse stated that the child had always been well until four months before admission to the hospital, when he became restless, lost his appetite, and decided indications were apparent that his condition was subnormal. Shortly before Christmas (1923) he complained to the nurse that he had an ache in his side. The tumor mass was first noticed by the mother about six weeks before admission. The mass had been growing progressively larger since that time. There had been marked loss of weight and appetite. Pain and urinary symptoms were absent.

Physical examination revealed a small, pale, and anemic child, indicating undernourishment and poor muscular development. Head and neck were negative. The chest had decidedly limited expansion. The left lung was relatively duller posteriorly than the right; a sharp flare of the left costal arch due to the abdominal tumor. The heart sounded clear and rapid; some accentuation of the aortic second.

A large tumor mass occupied the entire left half of the abdomen, extending up beyond the left costal arch and downward into the left iliac fossa well below the crest of the ilium and to the right to the anterior axillary line. There was no notch.

Blood examination showed: Red blood cells, 3,900,000; white blood cells, 22,000; hemoglobin, 85 per cent.

Urinalysis report was: Reaction, acid; albumin, 1+; sugar, 0;

blood, 0; bile, 0; sediment, casts, 0; red blood cells, 0; and a few leukocytes.

Cystoscopic examination was negative. The ureters were catheterized. No urine was obtained from the left side. Urine from the right side and from the bladder was sterile; no pus.

Thirty-one per cent of phthalein was excreted from the right kidney in thirty minutes. There was no excretion from the left kidney.

Roentgen-ray examination was negative for stone.

Pyelogram showed that no fluid entered the left kidney pelvis, because of obstruction due to the tumor.

Pre-operative diagnosis was malignant tumor of the kidney.

Operation was performed April 29, 1924, under ether anesthesia (Dr. H. L. K.). An enormous, solid tumor mass was found; very vascular and firmly fixed, with large, dilated vessels. Several sections were removed for histological study. The wound was closed without attempting to remove the tumor mass. The child left the operating room in poor condition. It was felt that because of the large size of the tumor and its firm fixation, and also because of the poor condition of the child, a nephrectomy was out of the question.

The postoperative course was uneventful. The patient left the hospital, May 6, 1924.

Histology.—Epithelial cell masses; spindle shape cell masses containing new, sharply defined tubules; dense epithelial cell nests containing new, sharply defined tubules; diffuse fibrous tissue hyperplasia containing solitary epithelial cells with large, pale coarsely granular nuclei; isolated, indistinct single strands of striated muscle fibers; extensive necrosis and compression atrophy with focal masses of disintegrated leukocytes.

Case 14.—F. L., male, white, aged two years, was admitted to the Presbyterian Hospital on the service of Dr. Arthur Dean Bevan, March 23, 1921.

The complaint on admittance was tumor of the abdomen. Two months previous to admission the mother noticed that the child's abdomen was rather hard and large, but thought it not unusual. She was told that the child's abdomen was not unusual. Three weeks prior to admission to the hospital the patient had a fall, bumping his right side on a sharp corner. Following this, his nurse noticed an enlargement of the right side of the abdomen. The mother was under the impression that the child lost some weight during the past two weeks, due to dieting. There was no history of pain or frequency or the presence of gross blood in the urine.

Examination of the head, neck, heart and lungs was negative.

Examination of the abdomen revealed a very large tumor which was movable and had a dull note on percussion, in the right side.

Blood examination showed: White blood cells, 8,300; hemoglobin, 65 per cent.

Urinalysis report was: Reaction, acid; albumin, 0; sugar, 0; blood, 0; bile, 0; sediment, casts, 0; occasional red blood cell and a few leukoctyes.

Fluoroscopic examination of the gastro-intestinal tract was negative.

Roentgen-ray examination was negative.

Pre-operative diagnosis was tumor of the kidney.

Operation was performed by Dr. A. D. Bevan March 25, 1921 under gas and ether anesthesia. Right nephrectomy was done.

The patient made an uneventful recovery and was discharged from the hospital, April 6, 1921.

Histology.—Fibroblastic stroma; loose undifferentiated cell stroma, which elsewhere was in dense clumps containing indistinct new tubules and clumps of cells in the formation of new tubules. The undifferentiated cells had huge nuclei with sparse, coarse granules in them, isolated, smooth muscle fibers and striated muscle fibers; fibrous tissue masses containing large epithelial cells.

Case 15.—G. B., male, white, aged seven months, was admitted to the Presbyterian Hospital on the service of Dr. Allen, June 24, 1917.

Complaint on admission to the hospital was of a large mass in the abdomen and constipation. Two and a half weeks prior to admission to the hospital the mother had noticed the presence of a mass in the abdomen. Previous to this time the patient had been perfectly well. Constipation had been present for about a week. There was no loss of weight or appetite; no urinary symptoms. There had been a slight afternoon temperature up to 101.2 degrees.

Physical examination revealed a well-nourished and lively child. Head, neck, heart, lungs and extremities were negative.

Abdominal examination revealed a large mass the size of a grapefruit in the left side, firm in consistency, smooth and fairly movable; not tender. Testes were not descended.

Blood examination showed the count of white blood cells to be 8,500.

Urinalysis report was: Reaction, acid; albumin, 0; sugar, 0; bile, 0; sediment, casts, 0; blood, 0; few leukocytes.

Operation was performed by Dr. A. D. Bevan, March 26, 1917, under ether anesthesia. Left nephrectomy was done.

The patient left the hospital, July 7, 1917.

Histology.—Massive epithelial cell nests with huge number of large, sharply defined, new tubules, both in the nests and out in the loose stroma; striated muscle fibers abundantly ramifying throughout the epithelial cell nests and fibroblastic stroma.

Case 16.—D. S., male, white, aged three years ten months, was

admitted to the Presbyterian Hospital on the service of Dr. C. G. Grulee, July 16, 1919.

The patient complained of general weakness, pain on the right side and stomach-ache. About five weeks before admission to the hospital, while walking down the street, he fell, and complained of pain in the right side. He was carried home and had been in bed most of the time since. On rare occasions he walked about the room, but seemed very tired. A few days after the fall the mother noticed the presence of blood in the urine, which had been present in varying amounts. At times the urine appeared free of gross blood. Pain in the side was almost continuous; pain in the left side occasionally. Urinary symptoms were absent.

Physical examination revealed a well-nourished child who did not appear ill. Temperature was normal. Head and neck were negative. Chest, heart and lungs were negative, except bronchial gland dullness extending to the third spine.

The abdomen was very protuberant, more so on the right side than on the left. There was a hard, resistant tumor mass felt in the right upper quadrant that extended from the costal margin in a line 2 inches from the midline down to the level of the antero-superior iliac spine back to the spine in the lumbar region. The liver was palpable, being pushed over to the left. The spleen was not palpable, nor the left kidney. External genitalia were negative.

Blood examination showed: Red blood cells, 4,050,000; white blood cells, 9,900; hemoglobin, 85 per cent.

Urinalysis report was: Reaction, acid; albumin, trace; sugar, 0; sediment, occasional hyalin and granular casts; blood, trace; many leukocytes.

The Von Pirquet test was negative.

Cystoscopic examination of the bladder was negative. Ureters were normal, no obstruction. Urines from the right and left kidneys were sterile and free of pus.

Operation was performed July 19, 1919, under ether anesthesia (Dr. H. L. K.). A right nephrectomy was done. The tumor was unusually large, surrounded by many large blood vessels, and there was much bleeding due to the presence of these enlarged veins. The tumor was delivered with great difficulty, the pedicle isolated, clamped and ligated, and the kidney and the tumor were removed. The patient left the table in very poor condition due to shock.

The patient died that night. Permission to obtain an autopsy, unfortunately, was not obtained.

Description of Specimen.—The surface was irregularly nodular in the lower half and fairly smooth in the upper half. The lower half seemed to be made up of many small nodules. One large nodular mass was situated on the convex border. On the surface of the upper part were seen many small nodules, distinct and isolated.

On the surface made by cutting there was a very small amount of kidney tissue left, which formed a band at the outer side, varying in thickness, averaging 1 cm. The lower half of the tumor was hard and solid. The nodules were white in color with here and there a yellow tinge which seemed to be more marked in what appeared to be fibrous tissue. In the middle of the tumor, just under the surface, was a large yellow area, round in outline and about 3 cm. in diameter. Color was sulphur yellow (?). The upper half of the tumor was of a very dark color, extremely friable. Small nodules were seen in the renal parenchyma or what was left of it.

Histology.—Huge compact epithelial cells in nests containing new sharply defined tubules; both large and small similar tubules out in the fibrous stroma were abundant; elsewhere they were only few in number; central agglutination of cells in the epithelial cell masses forming new tubules; single strands of striated and non-striated muscle throughout the loose stroma; dense strands of fibrous tissue; diffuse focal compression atrophy with necrosis and masses of disintegrated leukocytes.

Case 17.—J. L., male, white, aged sixteen months, was admitted to the Presbyterian Hospital on the service of Dr. A. H. Parmalee, December 14, 1927.

Two weeks before admission to the hospital the parents noticed a mass in the upper left side of the abdomen. The mass was painful when handled and had grown rapidly since it was first noticed. The child was restless and did not sleep well at night, and there had been a slight rise in temperature. There were no urinary symptoms.

Physical examination revealed a well-nourished child who did not appear acutely ill. Head, neck, heart and lungs were negative.

There was a large, palpable mass in the upper left quadrant of the abdomen which seemed to be connected with the left kidney. Upon palpation the mass was tender.

Temperature was 99.2 degrees on admission.

Blood examination showed: Red blood cells, 4,300,000; white blood cells, 10,050; hemoglobin, 65 per cent.

The Von Pirquet test was negative.

Urinalysis report was: Reaction, acid; albumin, 0; sugar, 0; sediment, occasional white blood cell; blood, 0; few red blood cells.

Fluoroscopic examination, with barium meal, showed a displacement of the colon by mass in the left upper quadrant.

Roentgen-ray examination of the chest was negative except that the diaphragm was slightly elevated, probably pushed upward by the tumor. In the abdomen, the transverse and splenic flexure was pushed down by a mass filling almost the entire left upper quadrant.

Operation was performed December 16, 1927, under ether anes-

thesia (Dr. E. M. M.). Incision for exploratory laparotomy was made. A malignant tumor of the left kidney, the size of a large grapefruit, presented between the spleen and transverse colon, extending 2.5 inches to the right of the midline and as far to the left as one could feel; it was fixed posteriorly. No attempt was made to remove the tumor. A small piece of tissue was removed for histological study. Closure was made in the usual way.

The postoperative course was uneventful. The child was discharged from the hospital December 27, 1927.

The patient died, June 21, 1928.

Histology.—Huge epithelial cell masses containing new tubules which were only poorly defined, many of them suggestive of tubule formation because of central clumping of cells. Epithelial cell nuclei were large, pale stained and contained finely granular chromatin; diffuse fibrous tissue hyperplasia; isolated strands of non-striated muscle and indistinct striated muscle fibers stained with phosphotungstic acid hematoxylin.

PATHOGENESIS

The occurrence of distinct forms of mixed tumors of the kidney in children was first described in 1884, by Jacobi,[17] although in 1872 Eberth[9] noted that there were tumors of the kidney which contained more than one type of tissue, among them muscle elements, which he thought arose from inclusions in the kidney of portions of the Wolffian body. Credit is generally given, however, to Birch-Hirschfeld[1] for recognizing that these tumors have common histological features of neoplasms, and contain a mixture of epithelial and connective tissue elements proliferating in a most extensive embryonal manner. He agreed with Ebert that they have their origin from remnants of the Wolffian body. He says that the glandular tissue is primary and interprets the rounded cells as transition forms which may at any time differentiate into glandular structures.

In 1899, Wilms,[31] whose name is often attached to these tumors, published a monograph which cleared up much of the confusion which existed regarding their origin. Wilms' explanation of the origin of them has been generally accepted today. He showed that the mixed tumors of the kidney are composed of a variety of different tissues; that all the tissues developed from a cell tissue which did not show any of the known differentiating marks. Glandular elements are always present; smooth and striated muscle, cartilage, fat, elastic,

fibrous, and myxomatous tissue are nearly always present. Wilms disputed Birch-Hirschfeld's views for he said that, although the Wolffian body does contain non-striated muscle fibers, it does not contain any striated muscle fibers, which are so often present in these tumors. He assumed that these tumors arise from a

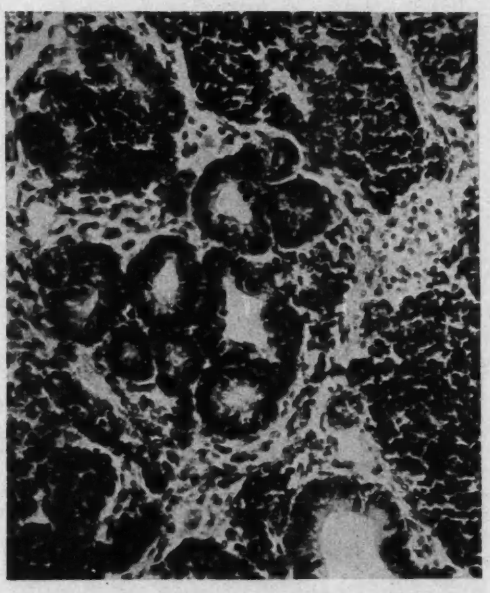

Fig. 8. The embryonic tubules which are a conspicuous feature of these tumors are sharply defined and are usually present within the circumscribed masses of undifferentiated cells with dense nuclear chromatin and many mitoses. These masses of cells have been called "epithelial cell nests." (× 200.)

scattered displacement of undifferentiated mesodermic germinal tissue which later gives rise, in the course of normal development, to the pronephros and Wolffian body and to the myotomes. This undifferentiated cell tissue must therefore have the potential quality of being able to produce all the different types of tissue, even though with our present limited status of the knowledge of cells this may appear too extraordinary to be plausible. In

other words, the cell tissue must be an embryonal germinal variety that is still in the first stages of development.

The primary segment or myotome furnishes the entire striated musculature of the region of the neck. This myotome also furnishes the musculature for the trunk and extremities. Granting

Fig. 9. Undifferentiated cells in diffuse masses without embryonic tubules are often present. These cells differ from those in the epithelial cell nests in that they are more polyhedral, have fewer mitoses, and less nuclear chromatin. (×480.)

that the entire transversely striated musculature is derived from the myotome, it is evident also that transversly striated muscle fibers occurring separate from the normal muscle fibers, as in the renal tumors, must be traced back to misplaced portions of the myotome.

The smooth muscle fibers arise from the mesenchyme. Wilms states that the smooth muscle fibers have as little relation to the

transversly striated ones, that is in their origin, as does adipose or cartilaginous tissue.

The possibility of development of bone is, of course, not always present and in rare cases bone has also been found. As a rule the external conditions of bone growth necessary for the bone are absent.

Wilms believes that the glandular elements found in these tumors take their origin from the Wolffian body. He is also of the opinion that they are not misplaced, in primary fashion, in the form of developed glands, but become differentiated gradually from the embryonal round cell tissue. This round cell tissue, lying in alveoli, has been misplaced from the Wolffian body and from the round cell, and, in secondary fashion, the glandular formation develops. This undifferentiated embryonal tissue, when it proliferates, may produce the tubules that simulate those in the Wolffian body; it may produce the embryonal muscle cells so often present in these growths, and likewise, if a portion of the sclerotome is carried along, cartilage also may be found. The tumors thus contain a mixture of tissues, any of which may predominate.

Herzog,[13] a year later, claimed that inasmuch as tumor growth in general is regressive, rather than progressive, it is not logical to assume that undifferentiated round cells later on become epithelia, first aggregating in irregular masses, and these then giving rise to regular tubular glands. He suggested that if the nephrotome is not cut off at the normal site, there could result an inclusion of a portion of either the myotome or sclerotome, or both. This could thus result in a matrix containing all those embryonic elements which occur in these mixed renal tumors.

There has been no essential contribution to these theories since that time.

Embryonal adenosarcoma of the kidney is the commonest tumor of the kidney in swine. In fact, it is the commonest of all tumors in swine. This was first observed by Day,[5] in 1899, who, in 1907, demonstrated the similarity between these tumors in man and in swine. They occur in young pigs usually, in one pole of the kidney, and destroy the kidney by pressure atrophy. They are frequently present in both kidneys, rarely produce metastases, and in one instance a tumor weighing 60 pounds was studied by Day.

These tumors differ from human tumors (Fig. 18) in that the tubules are more abundant, more sharply defined, and many of them are folded into a papillary-like structure. Smooth muscle is abundantly present, but striated muscle has not been found. Bone and cartilage are usually present in swine tumors and

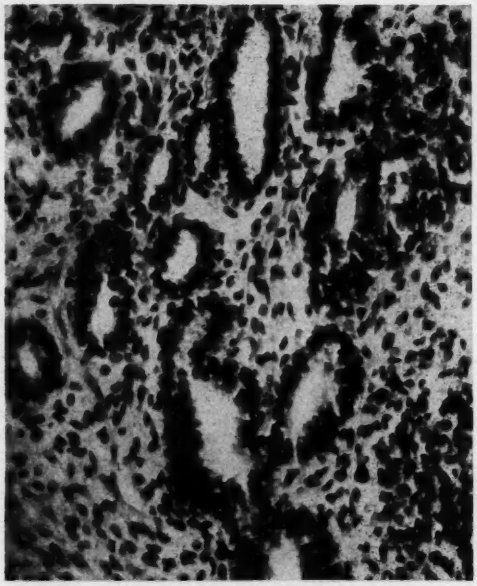

Fig. 10. The tubules often occur in the loose stroma outside of the undifferentiated cell masses and are usually sharply defined. (× 325.)

seldom in the human. These tumors have never been described in cattle or sheep.

GROSS PATHOLOGY

These embryonal tumors of the kidney are the commonest primary neoplasms which occur in children. These tumors, which are occasionally bilateral, have been described as of such size at birth as to cause dystocia. The largest of our tumors weighed 1,530 grams, the smallest, 235 grams, and the average weight

of all of our tumors was 762 grams. They are predominately unilateral; only two of the seventeen were bilateral. They are encapsulated, retroperitoneal and arise within the kidney capsule. The involved kidney usually occupies the entire side of the abdomen and displaces viscera in direct proportion to the

Fig. 11. Cross striated muscle fibers when present usually occur in clumps throughout the stroma and occasionally in definite bundles. (× 750.)

size of the tumor. They are globular to oval shape, solid, opaque and variously subdivided into lobules. Somewhere on the surface a nodule of kidney tissue usually remains. This kidney tissue is normal in all essentials except when it is adjacent to the tumor, where it is compressed and thins out to cover the neoplasm, nearby, usually for several centimeters, so that at its peripheries it may be only a millimeter thick. These tumors arise within the kidney itself. They may occur in any portion of it and compress the kidney so that it undergoes pressure atrophy. The kidney takes no part in the tumor formation, so

that a layer of fibrous tissue free of renal structures separates the tumor from what remains of the compression-atrophied kidney. The kidney and its adherent neoplasm are intimately fused together and cannot be separated from each other without extensive laceration, except for that peripheral nodule of kidney

Fig. 12. Higher magnification of same section as shown in Figure 4.

not as yet compressed. The degree of kidney change in size and shape varies with the size of the tumor. A portion of kidney tissue about one-half the size of its opposite kidney was the largest amount of kidney substance remaining adherent to the tumor fused with the neoplasm in any of our patients. The amount of kidney tissue remaining varied from a portion of a pole of the kidney downward to a band of kidney tissue 1 to

2 mm. thick where it covered the neoplasm. The surface consists of the capsule raised irregularly by rounded nodulations. The nodules vary from pea size to the size of an adult's clenched fist. The new growth generally is firm and essentially retains its shape when placed on a hard surface. They are gray to pink outside and only delicately vascular.

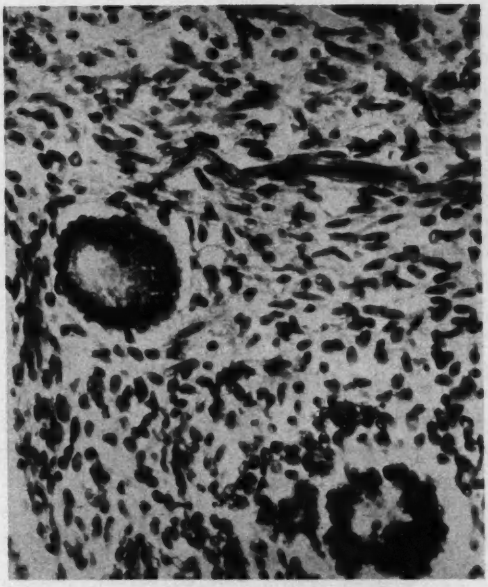

Fig. 13. Cross striated muscle fibers may also occur within the masses of undifferentiated cells adjacent to tubules. (× 390.)

The surfaces made by sectioning are uniformly firm, fibrillar, lobulated, and gray to faint pink-yellow in split-pea size places. Lobules are from 2 to 6 cm. in general diameter. They are separated from each other by fibrous bands. Most of the lobules are firm throughout except for isolated portions which are soft, friable, with the consistency of an infant's brain. Elsewhere

they are pink to dark red, in places 4 to 6 cm. across. These portions are soft, porous to sponge-like with compressible resistance, and moist. Although this portion is fused intimately with the gray tumor tissue it is in sharp contrast to the major portions, which are gray. The soft, fluid-like places are those of compression-atrophy and liquefaction necrosis.

MICROSCOPIC PATHOLOGY

The embryonal structure of these tumors is their most distinguishing feature with a variety of tissue of abortive renal elements. The types of cells and amount vary in the different tumors. They are usually myxomatous tissue composed of masses of polymorphous, nucleated cells in which are imbedded gland or duct-like figures resembling uriniferous tubules, which may be sparse or abundant. These embryonic tubules in a heterogeneous matrix are the most conspicuous features. There are both epithelial and connective tissue elements. The epithelial elements consist of small and large undifferentiated cells which are often spoken of as epithelial cell nests, and embryonal tubules. The connective tissue elements consist of loose stroma, undifferentiated round cells, striated and non-striated muscle fibers. These elements are most irregularly mixed. The tubules are in many stages of development and usually consist of single layers of cuboid and columnar-type epithelium, although several layers are occasionally present resting on a thin basement membrane. The tubules in general are round, but occasionally have horseshoe shape luminæ which may be irregular in outline. The tubules may occur in dense lobular clumps separated by only a few cells or they may be present as a single tubule in solid masses of undifferentiated cells which are dividing rapidly. The lumen of the tubule occasionally may not be visible and other tubules in the process of growth may be indicated by a clumping of the cells in the central portions of the masses of undifferentiated cells. The chief features of these cells are their polymorphism, abundance of mitotic figures, and dense chromatin. They may have fragmented nuclei, and but little cytoplasm. The stroma between the masses of embryonal cells is myxomatous and delicately fibrous. The epithelial cell nests, which stain deeply, are often sharply defined from other undifferentiated masses

of cells which are more round, contain less chromatin and fewer mitoses. The fibrous bands which group the tumor cells in rather large clusters contain, in places, cells with spindle-shape nuclei which are usually sparsely distributed.

Striated muscle is another interesting feature of these tumors. These fibers are best stained with phosphotungstic acid hema-

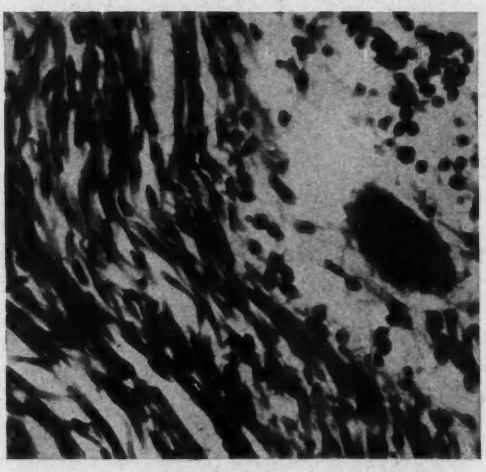

Fig. 14. Non-striated muscle is usually present in these tumors and occurs chiefly in compact masses. (× 480.)

toxylin. Striated muscle is present in the majority of these tumors. It is present usually in clumps of fibers, but occasionally single strands of striated muscle ramify throughout the epithelial cell masses. Non-striated fibers are present in all of these tumors and are usually present in compact clumps in an orderly arrangement.

Aberrant cross-striated muscle fibers have also been observed in the thyroid gland (Hirsch), and in the sino-auricular node (Yates).

Necrosis of the tumor itself is often marked. It usually is most marked where growth has been most rapid.

In the portion of the kidney not yet obliterated, where the kidney is adjacent to the tumor, the tubules are usually widely dilated.

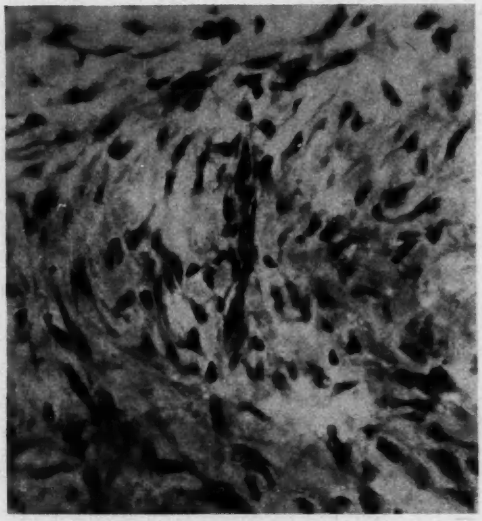

Fig. 15. A loose, spindle cell stroma is always present in some portion of these tumors. (×480.)

The recurrences of tumor growths following surgical excision of the primary tumor have all been histologically similar to the original tumor structure.

Cartilage or bone was not found in any of our tumors.

METASTASES

Extensions and metastases of these tumors are exceptional unless the original tumor is large. Regional involvement by extension is the usual method of growth. Extension-metastases may occur throughout the entire abdomen, engulfing the viscera by its growth so as to enclose completely such viscera as the

pancreas and suprarenals. They may penetrate through the walls of the blood vessels, usually the veins, in one instance a ureter, and may extend through the diaphragm so that tumor nodules may be present on its pleural surface. Hematogenous extensions are predominately toward the liver and occasionally toward the lung. Metastases in the liver (Fig. 16) duplicate remarkably the typical new tubule formation. These tubules may be present in clumps or single tubules in a matrix identical to that of the primary tumor. Muscle fibers were not seen in the metastases. Metastases in the lungs (Fig. 17) are usually nodules 1 to 3 cm. in diameter. They are firm, gray, and sharply defined. These consist of undifferentiated round cells with scant chromatin.

In isolated places they retain a mass of polymorphous cells, with dense chromatin, arranged in a compact cluster, and resemble abortive renal tubules. These extension metastases may be so huge as to compress great veins or by compression in the liver bile cysts may result.

SEX

As a rule the question of sex is of but little moment as an aid in making a diagnosis, so that the sex incidence is only one of academic interest. Still it is extremely interesting to note that in this series of seventeen cases, fourteen of them occurred in males whereas only three were females.

AGE

The oldest case in this series was six and a half years and the youngest, 3 months.

Under 6 months	2 cases
6 months to 1 year	1 case
1 to 2 years	5 cases
2 to 3 years	3 cases
3 to 4 years	1 case
4 to 5 years	0 cases
5 to 6 years	3 cases
6 to 7 years	2 cases

ONSET

The time that had elapsed between the time when the symptoms were first noted and when the parents took the little patients to the doctor for examination was as a rule very short. This varied from six days in one case to twelve months in the longest. It was exceedingly hard to get an accurate line

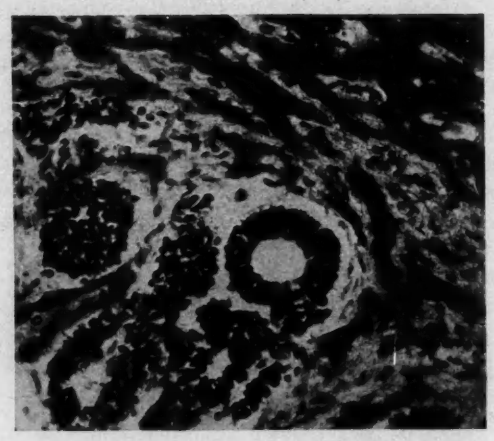

Fig. 16. Metastases in the liver. When present in the liver the metastases simulate the structure of the original tumor. (× 290.)

on the time of onset, i.e., to determine the length of time that the tumor had been present, because so many of these little patients when brought in had a relatively short period of onset or duration of symptoms; whereas, when the patients were examined, very large, extensive abdominal tumors were present and it was quite evident that the growth had reached its large size before its presence was discovered and the patients were sent in.

PAIN

In five cases the patients complained of pain in the region of the tumor. In Case 7 the tumor was located on the right side and the pain complained of was on the left side.

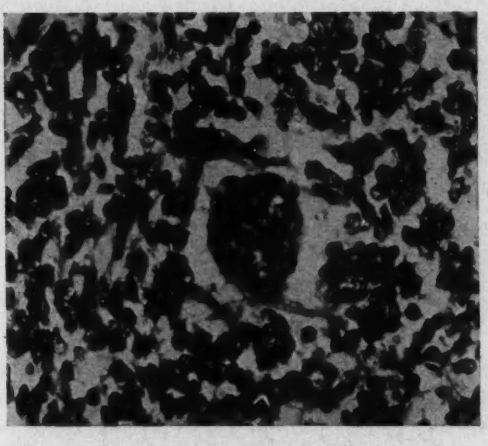

Fig. 17. Metastases in the lung. When present in the lungs the metastases consist essentially of undifferentiated cell masses with less nuclear chromatin than the cells in the primary tumor. The tubules are seldom sharply defined and are usually indicated by a clump of cells in a gland-like arrangement. (× 480.)

URINARY SYMPTOMS

Frequency of urination was present in only one case (Case 1). This symptom was not very severe and was present for four months.

Hematuria—gross blood—in the urine was absent. In one case (Case 2) the patient's history at the time of admission was negative on this point and the mother was told to look for blood in the urine. On the patient's second admission the mother said that since leaving the hospital there had been some bloody urine, but this was *not verified*. It would seem, therefore, from

a study of this series of cases, that the statement is justified that hematuria—gross bleeding—is rarely present in this type of tumor. Our own experience coincides with this view.

FEVER

An increase of temperature is often found in malignant tumors of the adult. Israel drew attention to this fact many years ago. An analysis of malignant tumors in the adult by one of us (Dr. H. L. K.[18]) showed an elevation of temperature in eleven in a series of fifty-four cases. But attention was drawn at that time to the fact that other conditions were present that might have been factors in the production of fever, such as infections in the teeth, tonsils and sinuses.

In this group of seventeen cases fever was present in nine cases.

GENERAL SYMPTOMS

Palpable tumor	17 cases
Fever	9 cases
Pain in abdomen	6 cases
Loss of appetite	4 cases
Loss of weight	3 cases
Constipation	3 cases
Irritability	2 cases
Vomiting	2 cases
Frequency of urination	1 case

SIDE INVOLVED

Equally interesting was the fact that although it is generally assumed that right-sided kidney lesions are more common than left-sided lesions, we find quite the reverse situation in our studies, in that in ten of the seventeen cases the malignant tumor was found on the left side and in five on the right. In two cases (Cases 4 and 12) there was a bilateral involvement, an exceedingly rare finding as far as we can tell, judging from case reports in the literature (Fig. 7, Case 12). Whether this was due to a primary tumor developing in the remaining kidney after the

decapsulation or whether the growth was metastatic is a question which we feel we cannot positively answer.

The distribution of lesions among the seventeen cases reported is as follows: Left, ten cases; right, five cases; bilateral, two cases.

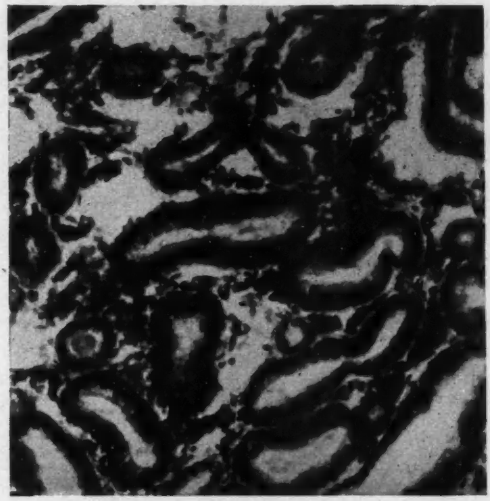

Fig. 18. Embryonal adenosarcoma of the kidney in swine. In these tumors of swine the conspicuous feature is the abundance of tubular structures of various shapes and sizes. The tubules in swine tumors are evidently more mature than in the human. Striated muscle is seldom present, but nonstriated muscle, cartilage, and bone are commonly found. (× 325.)

PRESENCE OF TUMOR

In every one of these cases a palpable tumor was present. In all but one the presence of the tumor was directly responsible for the patient's being brought to the physician. As a rule, the tumor was discovered accidentally either by the mother or a

nursemaid, and therefore was the first symptom. Furthermore, a careful review of these cases showed that the presence of the tumor was about the only symptom complained of. In only three of these patients was there a direct history of trauma (Cases 11, 14 and 16).

URINALYSIS

Albumin was present in seven cases; microscopic blood was found in only one case. In one case the presence of sugar was noted. When this patient entered the hospital the urine was negative.

Following reentrance on account of extensive abdominal metastases, particularly in the region of the liver, an examination of the urine revealed the presence of sugar. The metastatic masses involved the liver. In three cases a few red blood cells were found in the urinary sediment.

URINALYSIS

Albumin	7 cases
Leukocytes	5 cases
Red blood cells	3 cases
Casts	2 cases
Microscopic blood	1 case
Sugar	1 case

WASSERMANN TEST

Wassermann tests were negative.

BLOOD COUNTS

In every case there was present a very definite evidence of a secondary anemia. This was most marked in Case 2, in which the red count was 2,000,000. There was an increase in the white blood cells in eight cases. The highest count was 28,650.

CYSTOSCOPY AND URETERAL CATHETERIZATION

The problems of diagnosis and the study of renal function in these cases do not differ from those in the adult. All these

patients should be subjected to cystoscopic examination and ureteral catheterization for purposes of making a pyelogram and in order to determine the function of the opposite kidney. An intravenous pyelogram may be made before the cystoscopic examination is carried out and, if necessary, this can be checked with pyelograms from below.

The cystoscopic examination when done was negative.

In one case the pyelogram was practically normal outside of showing a few minor changes in the calices due to clubbing, but there was no compression and filling defect such as one generally sees in malignant tumor.

Because the large size of the tumors caused the kidney pelvis to be completely filled, many of the cases showed so complete a blocking at the uretero-pelvic junction that no pyelogram could be obtained.

This type of finding may at times be confused with a block at the uretero-pelvic junction due to a large hydronephrosis associated with kink and thereby preventing a filling of the kidney pelvis. In one of our cases, in which the tumor was rather soft and elicited a feeling of slight fluctuation, the possibility of hydronephrosis was considered.

The pyelogram is not only of value in differentiating various types of kidney lesions, but it is also valuable in differentiating lesions of the liver and spleen as well as those rare cases of tumors of the adrenal, hydronephrosis, solitary cyst of the kidney and congenital polycystic disease, although solitary cyst of the kidney and congenital polycystic disease rarely call for differentiation in early life. Finally, the importance of determining the presence of a second kidney and of estimating its function before nephrectomy is just as important in children as it is in adults. A point that should be stressed is the possibility of bilateral involvement, inasmuch as we found this complication in two of seventeen cases, that is, nearly 12 per cent.

SUMMARY

1. A series of seventeen cases of this supposedly rare and unusual type of kidney tumor is reported.

2. Some of the cases were incorrectly diagnosed and a subsequent study by us revealed the true nature of the tumor.

3. This type of tumor is the commonest tumor in swine.

4. A careful histological study of specimens is convincing that this growth is the common tumor of infancy and childhood.

5. Hematuria, so common in the adult, is rarely, if ever, present in children.

6. Most of the patients are seen when the tumors have reached an enormous size.

7. The prognosis is bad; sixteen of the seventeen patients have died.

BIBLIOGRAPHY

1. Birch-Hirschfeld, F. V., and Doderlein, A.: Embryonale Drusengeschwulst der Nierengegend im Kindesalter, Centralbl. f. d. Krankh. d. Hern-u. Sex.-Oreg. 5:3, 1894. Birch-Hirschfeld, F. V.: Sarkometose Drusengeschwulst der Niere im Kindesalter (Embryonales Adenosarkom), Beitr. z. path. Anat. u. z. allg. Pathol., 24:343-362-Jena, 1898.
2. Bondy: Jour. A. M. A., LVI, p. 973, 1911.
3. Bugbee and Wollstein: Jour. A. M. A., LXXXIII, pp. 188-189, Dec. 13, 1924.
4. Castle: Surg., Gynec. & Obst., XVIII, pp. 477-483, 1914.
5. Day, L. Enos: D. V. S., U. S. Dept. of Agriculture, Bureau of Animal Industry, 24th annual report, pp. 247-257, No. 55284.
6. Deming: Jour. A. M. A., LXXX, pp. 902-905, 1923.
7. Deming: Surg., Gynec. & Obst., XXXIX, pp. 432-442.
8. Downes: Jour. A. M. A., LXXVI, pp. 443-447, 1921.
9. Eberth: Arch. f. Path. Anat., etc., LV, 518, 1872.
10. Fullerton: Brit. J. Surg., XIII, No. 52, 1926.
11. Harris: Surg., Gynec. & Obst., pp. 191-193, August, 1925.
12. Hasner: Trans. Chicago Path. Soc., 1928, XIII, pp. 4-11.
13. Herzog, M., and Lewis, D.: Embryonal Renal Adenosarcoma. Amer. Jour. Med. Sci., 119, 693-701, 1900.
14. Hinman and Kutzmann: Ann. Surg., p. 569, October, 1924.
15. Hirsch: Jour. A. M. A.,
16. Hyman: Surg., Gynec. & Obst., pp. 298-310, September, 1925.
17. Jacobi, A.: Primares Sarcom der Niere bei dem Foetus und dem neugeborenen Kinde, Jahrb. f. Kinderh., 25:112, 1886. (Read before the Eighth International Congress for Medical Sciences at Copenhagen, 1884.)
18. Kretschmer, H. L.: Early Diagnosis of Malignant Disease of the Kidney. Jour. Southern Med. Assn., XVIII, pp. 92-99, Feb., 1925.
19. Lain: Med. Jour. & Rec., April 4, 1928.
20. Lowsley and Butterfield: Jour. Urol., XVI, p. 415, December, 1926.
21. MacCarty and Magoun: Surg., Gynec. & Obst., XXXVI, pp. 781-786, 1923.
22. Mixter: Ann. Surg., LXV, p. 628, 1917.
23. O'Neil: Boston Med. & Surg. Jour., CLXXIII, pp. 873-877, 1915.
24. Phifer: Ann. Surg., LXVII, pp. 711-720, 1923.
25. Porter and Carter: Am. Jour. Dis. Child., XX, p. 323, 1920.
26. Robins: Ann. Surg., LXXVII, pp. 306-310, 1923.
27. Simmons: Jour. A. M. A., LXVIII, pp. 1899-1900, 1917.
28. Smith and Motley: Surg., Gynec. & Obst., XX, p. 419, 1915.
29. Thomas: Surg. Cl. North America, 1923, III, p. 1255.

30. THOMAS and BIRDSALL: Jour. A. M. A., XCI, p. 1428, Nov. 10, 1928.
31. WILMS, M.: Die Mischgeschwülste, Leipzig, Arthur Georgi, 1899.
32. WOOD: Internat. Clin., Vol. III, Ser. 26.
33. WOLLSTEIN: Arch. of Pathology Laboratory of Medicine, 1927, VII, pp. 1-13.
34. YATER: Jour. A. M. A., Vol. 94, No. 16, p. 1232, April 19, 1930.

ON THE PATHOGENESIS OF BLEEDING IN TUMORS OF THE KIDNEY

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Hematuria is so welcome a sign in renal tumors, and, as the French say, is so revealing and denunciatory, that ordinarily little thought is given to the matter of its pathogenesis. Many authors do not discuss the matter. One merely states that hemorrhage is the effect of the opening of blood vessels by the neoplastic process. Most find it natural to ascribe the bleeding to the great vascularity of tumors of the kidney, the fragility of their capillaries, and the extreme frequency of hemorrhage into the parenchyma of the tumor, particularly when the tumor is in the pelvis, has invaded it, or makes a salient into it.

Undoubtedly in some of the hematurias secondary to renal tumors, hemorrhage does occur from the tumor itself, as a result of loss of continuity of its surface. We have seen such cases, in some of which there were large numbers of tumor cells in the urine. Ljunggren has shown that not only do such lesions occur but that their site may be repaired by the organization of the covering blood clot. It may be argued, however, that in free hemorrhage in renal tumors it is not common to find tumor cells in the urine. When bleeding results from a loss of continuity of the surface of a tumor projecting into the pelvis, one would expect to find tumor cells in the urine. The presence of tumor cells in the fluid of the thorax in malignant disease of the lung and pleuræ is demonstrable in a high percentage of cases, even though the tumor cells are present in small numbers. If successful in this field, it should be easier to demonstrate the presence of tumor cells in the urine.

Where the tumor is situated in the cortex, however, the explanation above mentioned is less satisfactory. Albarran and Imbert quote the case of a cortical tumor, with abundant hemorrhages, in which there was no communication with the calices. To them, "it appears certain that in a large number of cases it

is the parenchyma itself and not the tumor which bleeds." In other words, the bleeding is due to congestion or passive hyperemia induced by the presence of the neoplasm in the renal parenchyma. Guyon is insistent that congestion and not ulceration plays the dominant rôle in these hematurias. Our search of

Fig. 1. Pyelogram showing right angled deviation of the ureter and crescentic filling defect of upper margin of left kidney pelvis, with slight dilatation.

the literature, however, has revealed but little actual proof, histological or otherwise, of the manner in which it occurs. A recent case of renal tumor with hematuria, in which the tumor made a small salient into a calix, has given the opportunity of making a careful study, by serial sections, concerning the source of the hemorrhage.

CASE REPORT

Male, aged forty-three years, was admitted to hospital, January 14, 1930, complaining of hematuria and pain in the left loin. Hematuria was first noticed in September, 1929, in four or five urinations. Except for a severe colicky pain in the left loin on one occasion, urination was painless. Hematuria recurred January 5, when there were several blood stained urinations, one with a similar colicky pain, and again on January 8 and 13. The pain was so severe on this last occasion as to induce the patient to seek hospital relief.

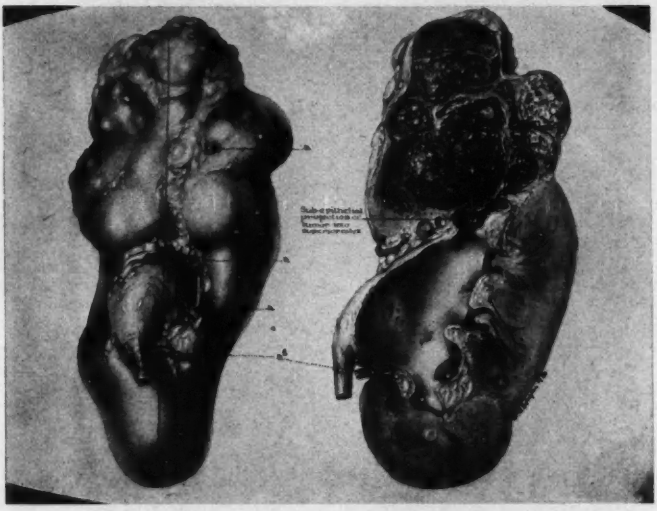

Fig. 2. Photograph of drawing of the gross specimen. Note the small projection into the superior calix and the dilated pelvis, the aberrant arteries *A* and A^1, the latter partially obstructing the ureter.

On admission physical examination was negative. The kidneys were not palpable. Urinalysis showed blood cells in profusion. X-rays were negative for calculi and metastatic deposits. Cystoscopy was done January 16, 1930; catheter specimen blood stained. The left ureteral orifice was concealed by a small blood clot. The bladder was otherwise normal. The ureters were catheterized. Specimens were taken for urinalysis, phthalein injected intravenously and the output estimated. The right kidney delivered clear urine, phthalein appearing in three and one-half minutes, in good concentration. The flow from the left kidney was unsatisfactory, phthalein only

appeared in fifteen minutes, and in poor concentration. Bilateral pyelograms with sodium iodid 12 per cent were made. The left side showed a right angled deviation at the ureteropelvic junction, and a filling defect on the upper margin of a slightly dilated pelvis.

Diagnosis was tentatively made of renal tumor, with an aberrant lower polar vessel.

Operation was performed January 24, 1930, under intratracheal ether; left nephrectomy. A tumor at the upper pole was intimately adherent to the fatty capsule. This was dealt with by sectioning be-

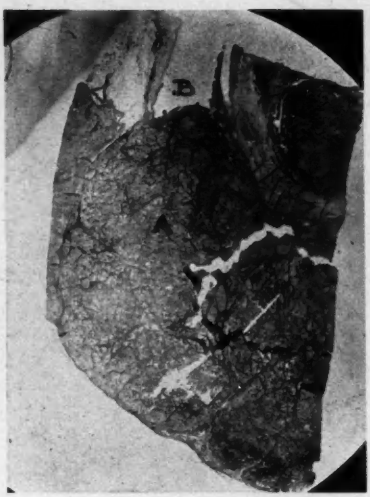

Fig. 3. Section through tumor *A*, and superior calix *B*.

tween ligatures. In so doing, an unsuspected aberrant upper polar vessel (artery) was discovered. There was also a lower polar vessel (artery) passing behind the ureter, its origin not definitely determined. Convalescence was without incident. The patient was discharged from the hospital, well, February 11, 1930. Deep X-ray therapy is being carried out.

Pathological Report.—(Dr. L. J. Rhea). (M. G. H. S-30-97).

"The specimen consists of a left kidney with 2.8 cms. of ureter attached. The kidney weighs 270 gm., is 16 cm. long, and 7 cm. in diameter at its upper pole and 5 cm. in diameter at its lower pole. The contour, surface, color and consistency of the organ is normal, with the exception of the upper pole, which is roughly nodular, has a mottled appearance and small fatty tags are adherent to it. The

nodules at the upper pole are moderately firm, have a rather rubbery feel, vary in color from pale gray to reddish blue, to yellow, and do not appear to have extended through the capsule, which is everywhere intact, and, with the exception of the tumor area, strips easily from the kidney substance. The kidney pelvis is somewhat dilated and surrounded by a considerable amount of normal fat. Three arteries enter the kidney at the pelvis. One of them occupies

Fig. 4. High power to show calix *A* and adjacent tumor *B*. Note epithelial lining of pelvis *C* and dilated blood vessels in sub-epithelial tissues *D*.

a position that, when within the body, it would have crossed the ureter in such a way as to obstruct it at least partially. On the median aspect of both the upper and lower poles, two small arteries enter the kidney substance.

"The pelvis is filled, but not distended, with 10 per cent neutralized formalin and the specimen swung in the same fluid for fixation."

After thorough fixation, a longitudinal section was made through the specimen to one side of the ureter, when the following was seen:

"The pelvis and calices are moderately dilated, are smooth and

show no gross lesions, with the exception of a small area in the superior calix, described later. With the exception of the upper pole, the kidney substance is normal.

"In the upper pole of the kidney there is a sharply outlined tumor 5 x 5 cms. in diameter, which is made up of reddish, bluish red to yellowish areas of varying sizes and shapes, and separated by pale connective tissue. Throughout the involved area the kidney substance appears to be completely replaced by this tissue. A pale, nar-

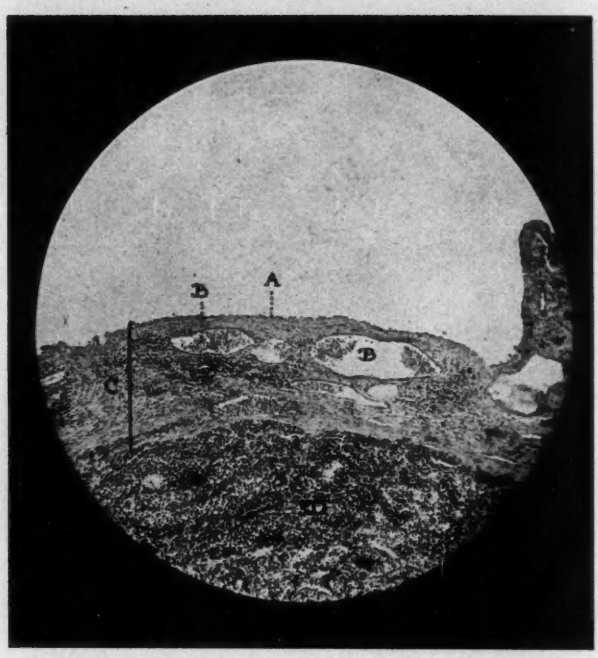

Fig. 5. High power photomicrograph of calix to show intact epithelium *A*; dilated vessels *B* in sub-epithelial connective tissue *C* and tumor tissue *D*.

row connective tissue-like border outlines the lower border of the tumor and forms an almost straight line which passes along the lower margin of the superior calix. The outer lateral wall of this calix shows a bluish red, slightly elevated area, which is 8 mm. long x 2 mm. wide at its central part, and pointed at each extremity. The surface of this area is smooth and no loss of continuity can be seen in it with a hand lens."

Anatomical Diagnosis.—"Hypernephroma of the superior pole of the left kidney with a small sub-epithelial projection into tthe superior calix. Multiple aberrant branches of the left renal artery. Dilated pelvis."

Miscroscopic Examination.—A block of tissue for microscopical examination was removed in such a way as to include the entire thickness of the tumor, all of the small epithelial projection into the superior calix, and a zone of surrounding kidney pelvis. The block was embedded in paraffin and cut in serial sections, 4 microns thick. Every fifteenth section was stained in one of several ways.

"The tumor is a typical hypernephroma which is everywhere surrounded by a connective tissue zone. Many of the blood vessels about the tumor are dilated. No tumor cells are found in any of the vessels. The connective tissue framework is rather scanty. The essential cells of the tumor are large, pale and transparent, and for the most part are arranged about round or oval spaces, whose outlines are either smooth or made irregular by papillary infoldings. Most of these spaces contain well preserved blood. In some areas there is hemorrhage into the necrosis of the tumor."

The serial sections were made primarily to establish the source of the hemorrhage and to determine what relation the small projection in the superior calix had to it. A study of these sections shows the following:

"The tumor cells are everywhere separated from the kidney pelvis by an intact epithelium and a thickened sub-epithelial zone of connective tissue infiltrated with a few lymphocytes and free from any evidence of old or recent hemorrhage. In none of the many sections examined were tumor cells found in the connective tissue just beneath the epithelial covering of the pelvis and in no instance did tumor cells reach nearer to the pelvic epithelium than is illustrated in Figure 4. In the sub-epithelial connective tissue are numerous, very widely dilated, and very thin walled blood vessels, some of which are just beneath the renal epithelium and project into the renal pelvis. None of these dilated vessels shows a point of rupture and none of them is thrombosed. There is no acute inflammation."

Microscopical Diagnosis.—"Hypernephroma of the upper pole of the left kidney. Dilatation of the blood vessels beneath a sub-epithelial projection of the superior calix."

CONCLUSION

Since we have been unable to demonstrate in any of the serial sections destruction of the lining of the pelvis by tumor, we feel justified in concluding that the hematuria resulted from widely dilated, very thin walled blood vessels in the sub-epithelial connective tissue of the small protrusion into the superior calix.

There is every reason to believe that these blood vessels, as widely dilated and as poorly supported as they are, might bleed, just as similar vessels do elsewhere in the body.

BIBLIOGRAPHY

ALBARRAN and IMBERT: Les Tumeurs du Rein. Paris, 1903, p. 235.
GUYON: Leçons cliniques sur les maladies des voies urinaires. Paris, 1894, vol. 1, pp. 495-496.
LJUNGGREN, E.: Verhandlungen der Deutschen Gesellschaft für Urologie, IX Kongress, 1929, 136.
TUFFIER and BRECHOT: Encyclopaedie d'Urologie, Paris, 1914, vol. 2, p. 872.

CARCINOMA OF BOTH KIDNEYS

REPORT OF A CASE WITH REVIEW OF THE LITERATURE ON MULTIPLE PRIMARY MALIGNANT TUMORS

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The occurrence of carcinoma in both kidneys is sufficiently rare to make the following case seem worth reporting, and to attempt to determine if possible whether or not each growth was a primary tumor.

The patient, a man of fifty-six, was admitted to the hospital on January 20, 1930, with a history of hematuria, epigastric pain and nausea, and great loss of weight and strength. Two months previously he had first noticed blood in his urine and had passed varying amounts each day since that time.

In addition to the patient's pallor and emaciation, physical examination showed an hypertrophied heart with a systolic murmur, and an epigastric hernia. The abdomen and flanks were so rigid that the lower poles of the kidneys could not be felt definitely, although flat X-ray plates showed enlarged and low lying kidney shadows on both sides. There were no glandular enlargements palpable.

Cystoscopy showed a few small blood clots in an otherwise normal bladder, but no blood was seen coming from either ureter. No secretion of any kind came from the right ureter catheter, and from the left side a few drops of cloudy urine. Two per cent of phenolsulphonephthalein was excreted in fifteen minutes after a delayed appearance on the left side. A double pyelogram showed an incomplete filling on the left; on the right the pelvis was well filled but the upper calices seemed ragged. A second cystoscopy gave the same findings with no secretion at all from the right catheter. At the third cystoscopy indigo carmin was given to watch the right ureter for evidence of patency, but on introducing the cystoscope a long worm-like cast of blood was seen protruding from the right ureter, which for the first time located the source of the hemorrhage. Indigo carmin appeared in faint concentration from the left ureter in thirteen minutes, but not at all from the right side for an hour. A tumor of the right kidney was then diagnosed, but it was still uncertain what conditions existed on the left side. X-ray plates of the chest, pelvis, and long bones showed no evidence of metastases. The patient's blood contained 3,250,000 red cells, 7,800 white cells,

and 60 per cent hemoglobin. The blood chemistry was urea 30.38, creatinin 2.1; the blood pressure, 116 systolic, 88 diastolic.

At this time the patient began to lose alarming amounts of blood, and was given a blood transfusion. The hemorrhages continued, however, to such a degree that a right nephrectomy was accepted as a means of prolonging life, in spite of the known pathology in the left kidney.

The pathological report on the right kidney was as follows:

Fig. 1. Carcinoma of both kidneys.

Gross Specimen.—Kidney measured 14 x 6 x 5 cm. Capsule stripped fairly easily. Peripelvic tissue was edematous and hyperemic. Surface of kidney was pale grayish brown color studded with nodules which were elevated and of a homogeneous grayish color; on section the cut surface showed numerous isolated and conglomerate areas which were pale grayish in color—the upper pole was covered with new growth.

Section was made up of kidney structure showing invasion with groups of tumor cells arranging themselves in cord-like and alveolar formation. These cells in some areas had a somewhat transitional appearance as though originating from the pelvic mucosa.

Diagnosis.—Transitional cell carcinoma of the kidney originating from the pelvis.

The patient stood the removal of the right kidney well, and for some days seemed stronger. There was no further macroscopic

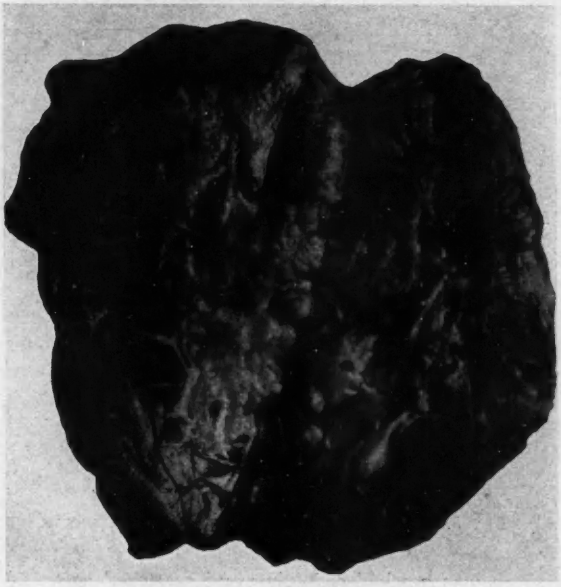

Fig. 2. Right kidney. Transitional cell carcinoma.

blood in the urine. The remaining kidney excreted varying amounts of urine in twenty-four hours up to 2,100 c.c. Urinalysis showed an acid reaction; sp. gr. 1.016; albumin a trace; sugar none. In the sediment were considerable pus, rare casts, and a few red blood cells Three weeks after operation the patient grew rapidly weaker and died March 8, of uremia.

Permission for a complete autopsy was refused but the left kidney was obtained Much to our surprise this kidney, which was larger than the one removed at operation, had its upper and middle thirds entirely replaced by a closely packed mass of carcinoma, the gross

appearance of which was wholly different from the scattered nodules of tumor in the other kidney.

The pathologist reported: The left kidney was greatly enlarged and almost completely occupied, except for a small amount of kidney substance in the lower pole, by a large tumor mass which was soft in consistency, and of a yellowish gray appearance. On

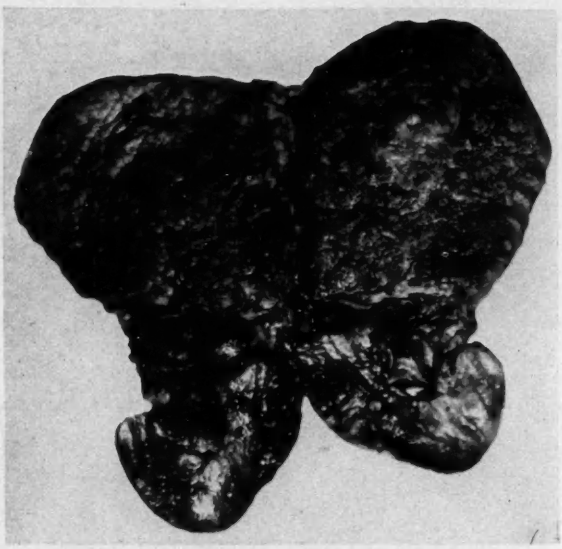

Fig. 3. Left kidney. Transitional cell carcinoma.

section there was marked softening and scattered areas of hemorrhage and necrosis. Microscopical section revealed the presence of tumor cells arranged predominately in a papillary formation. In other areas the structure of the tumor resembled that found in the right kidney.

Diagnosis.—Transitional cell carcinoma of the left kidney.

With these findings, it became of interest to attempt to determine whether the two carcinomata were independent primary growths, or one a metastasis from the other. On the subject of multiple primary malignant tumors the literature is extensive but confused, owing to the different classifications employed by various authors. Billroth, in 1889, set forth three conditions

which must be present to justify the diagnosis of multiple primary malignancy: (1) that the tumors must differ histologically, (2) that they must have different points of origin, and (3) that each must produce its own typical metastasis. These requirements are no longer accepted as necessary, and Major states that it is at present a well established fact that multiple primary malignancy may arise in any of the following ways:

Multiple identical tumors	in the same organ
	in the same system of organs
	in various organs
Different types of tumors	in the same system of organs
	in various organs

The multiple origin of carcinoma is also well proven, and Woolley believes that these cases do not represent an extension of one original focus through a tissue or organ or system, but the independent development of new growths of like histological character at separate points, and this presumably under the influence of a common stimulus. He says further that the analogy of multiple benign growths makes the theory of multiple malignant growths tenable without invoking metastases. The greater rapidity of development of malignant growths and the relatively early death of those affected tends to make more marked the difference in size between the first and subsequent primary growths, and so leads to the assumption of metastasis. Ewing believes the rather common occurrence of two or more tumors in different or the same organs of the same subject suggests nothing more than the accidental coincidence in several organs of the general biological factors in the genesis of tumors. Reasoning along the same line, Puhr concludes that multiplicity of tumors is common enough to indicate a definite tumor diathesis in certain patients. We shall be able to understand better the relation multiple primary malignant tumors of the kidney bear to the picture of multiple primary malignancies in general if we divide these cases arbitrarily into three classes:

1. *Multiple primary malignant tumors* in general, including the different forms of malignant tumors and the various organs and tissues in which they occur, represent, of course, the largest class. In these cases Orr employs the term "multiple malignant neoplasms" to signify the occurrence of two or more essentially different primary malignant tumors in the same individual, and

"multicentric tumors" for those in which the same growth appears more or less simultaneously in several places.

In a study of the frequency of multiple malignant neoplasms, Orr found, over a period of thirty-six years, 7,207 autopsies showed 1,046 cases of malignant disease, among which were

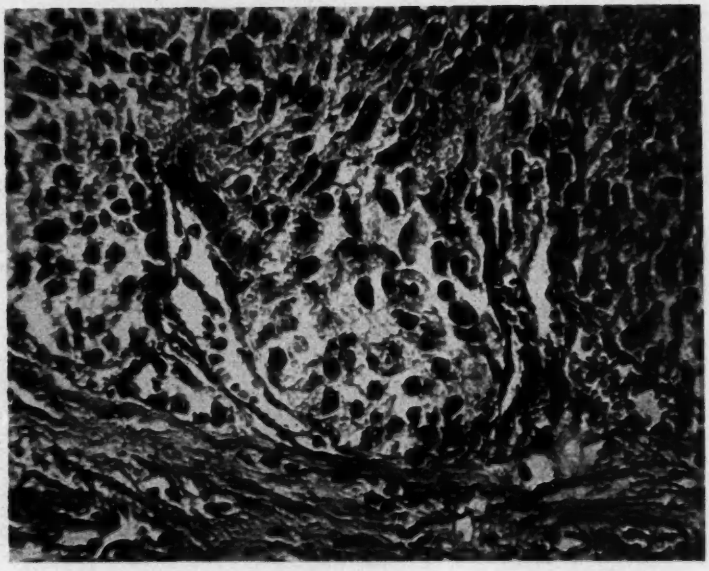

Fig. 4. Carcinoma of right kidney showing large irregular cells with only slight differentiation to cylindrical or spindle forms. Magnified 330 diameters.

eight cases of multiple malignant tumors—less than 1 per cent. He believes that there is no etiological relationship between such tumors, and that they occur purely as the result of coincidence. The sixth decade of life furnished the greatest number of cases.

Multiple primary carcinomata in various organs are not uncommon. Siebke has collected fifty-three well established cases from the literature and adds two of his own. None of these involved both kidneys. Since these cases most frequently occur in patients of advanced age, Siebke believes they are due to the lessened resistance of old age, when an unusual opportunity for growth is presented to nuclei of embryonic tissue. He has

further noticed that the tax on body resistance is less from one focus of carcinoma with its metastases than from two primary carcinomata. These latter patients die so quickly that often no metastases are found; and their course is so rapid that they are rarely diagnosed ante-mortem. Over a period of thirty-five years, Junghanns found that in 36,408 autopsies there were 4,192

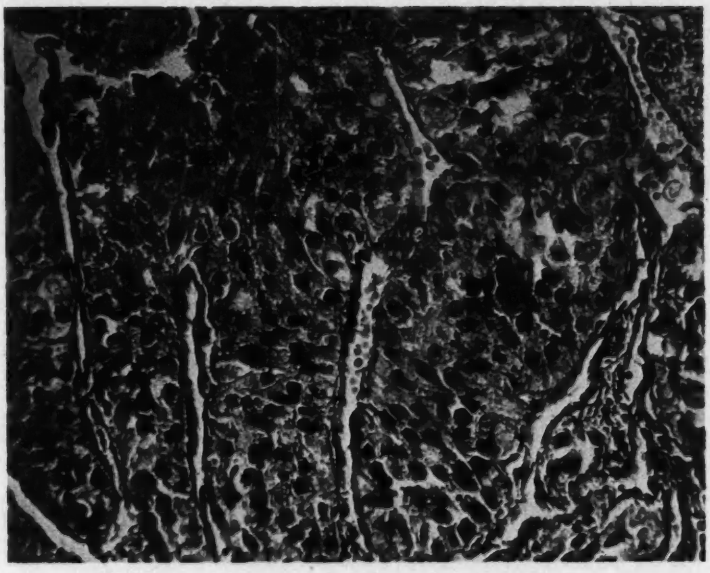

Fig. 5. Carcinoma of right kidney, showing vascularized supporting tissue with columnar and spindle form epithelial cells. Magnified 290 diameters.

cases of carcinoma, of which nineteen were multiple, eleven in men and eight in women. None of these cases were double carcinoma of the kidneys.

2. *Bilateral primary malignant renal tumors* include sarcoma, nephroma and carcinoma. Statistics of their relative frequency vary widely and are confusing. Ewing states that papillary adenocarcinoma is the most frequent of renal growths and that many of them are incorrectly recorded in the literature as hypernephromata. In the reports of other observers sarcoma occurs more frequently than carcinoma. A further cause of

confusion is the fact that cases of renal sarcoma of the small round cell type associated with round cell infiltration in glands, marrow, spleen and liver are reported by certain writers as primary kidney tumors while other authors, on account of the associated blood changes, believe them to be manifestations of a systemic infection of a leukemic or lymphosarcomatous type.

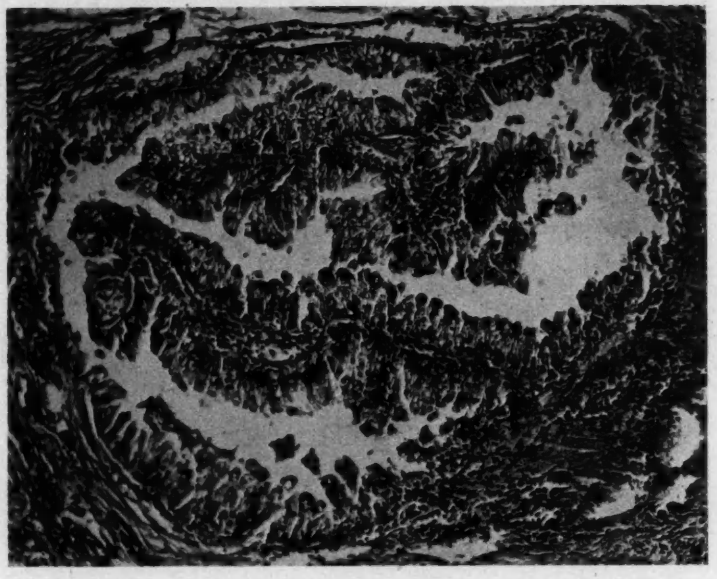

Fig. 6. Carcinoma of left kidney showing definite papilliform arrangement. Magnified 115 diameters.

Paul states that bilateral primary renal malignancy is more common in children than adults and that 50 per cent of all malignant kidney tumors in children are bilateral. Jacobi found eight bilateral cases in forty-one renal sarcomas. Küster, in 607 cases of renal malignancy, reports thirteen primary bilateral growths. Nicolich gathered from the literature nineteen cases of apparently primary bilateral malignant renal tumors. In eighteen of these, sarcoma was present on one or both sides. There was no instance of bilateral carcinoma. Kapsammer, in sixty-nine cases of renal tumors, found three primary bilateral instances.

Certain authors believe the involvement of the second kidney is usually a metastasis and that it is difficult to tell whether the lesion in the second kidney is primary or metastatic, unless the tumors of the two sides present a strongly different pathological character. This argument is weakened by the well known differences which often occur between the parent lesion and its metastases. Küster states metastases from malignant kidney lesions take place in the following order of frequency: lung, liver, glands, bone, and, much less often, the other kidney.

3. *Bilateral primary renal carcinomata* represent the rarest form of bilateral kidney tumors; according to Siebke, they occur in less than 1/100 of 1 per cent of all autopsies. Escalier reports one case, Steffen two cases, Lubarsch one case. A few other bilateral cases of renal carcinoma are on record, but the lesion in the second kidney was regarded as a metastasis from the first.

Metastases in renal carcinoma take place by the blood as well as by the lymph stream, owing to the tendency of renal tumors to grow into blood vessels. The lungs are most often affected, with liver, glands, bone, adrenals, renal vein and cava coming next in order. Lubarsch states that, in distinction to all other cancers, renal carcinoma metastasizes to the lung through the blood stream and he has never found the peribronchial glands affected. In true bilateral primary cases, however, metastases may be absent, as the course of the disease is so rapid. The symptoms in these rare cases may be atypical, and the fact that a double lesion is present may not be diagnosed before the autopsy.

In the present case, it is, of course, impossible to prove that the lesions in each kidney were primary, in the absence of a complete autopsy. The two kidneys, however, presented an entirely different macroscopical picture. On the left side the upper two-thirds of the organ were completely taken up by a compact rounded mass of cancer tissue, while on the right side lumpy nodules were scattered throughout the organ. Microscopically, the two lesions are identical, although in each kidney two or more types of cancer are present, and on the left side papilla formation is more marked.

Doctor H. T. Karsner, Director of the Institute of Pathology of Western Reserve University, who studied sections from both kidneys and to whom I am indebted for the microphotographs,

says: "The photographs are arranged to show (Fig. 4) the cancer in its undifferentiated form, where it might be called a carcinoma simplex; (Fig. 5) the cancer in a form similar to that seen in the usual cancers of bladder and renal pelvis, and (Fig. 6) the cancer with definite papilla formation. Taking the mass in the left kidney as a whole, the papilla formation simply shows

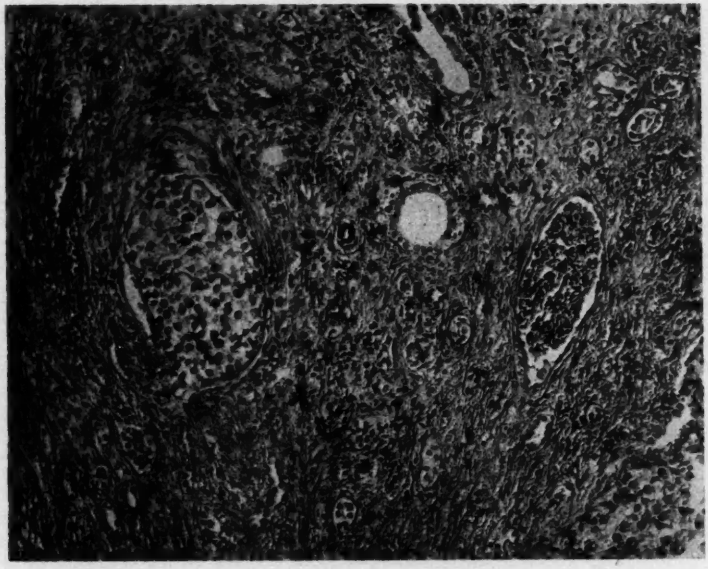

Fig. 7. Metastatic nodule of undifferentiated carcinoma in right kidney. Magnified 140 diameters.

a fairly high degree of differentiation and does not dominate the entire picture. It might be justified to speak of it as a papillary transitional cell carcinoma, but I personally would prefer to refer to it as a transitional cell carcinoma. I have made a fourth picture (Fig. 7) of the carcinoma to show how it metastasizes through the kidney in small undifferentiated nodules."

X-ray plates of the lungs were negative for metastases, and in view of the known predilection of renal carcinoma to invade the lungs, with two such advanced tumors it seems impossible for the process in one kidney to have been secondary to the other

without finding metastases in the lungs, where they are more likely to occur sooner. The short clinical course of the disease (4.5 months) and the absence of demonstrable metastases, is in favor of a bilateral primary renal carcinoma.

SUMMARY

1. A case of carcinoma of both kidneys is reported.
2. The literature on multiple primary malignant tumors is reviewed.
3. In the case reported, in the absence of a complete autopsy, it is impossible to prove that each lesion was a primary tumor, but conditions are pointed out that make such a theory tenable.

The writer wishes to acknowledge the coöperation of Dr. H. Sneiderman, Pathologist of St. Alexis Hospital, in the pathological study of the case.

BIBLIOGRAPHY

ALBARRAN et IMBERT: Les Tumeurs du Rein, Paris, 1903.
DUSCHL, L.: Ueber Primäre Multiplizität von Geschwülsten. Deutsche Zeitschr. f. Chirurgie 1925, CCXCIII, 177.
EGLI, F.: Ueber Multiplizität von Geschwülsten. Correspondenz. Blatt f. Schweizer Aertze, 1914, XLIV, 449.
ESCALIER: Semana Médica. 1902, IX, 927.
EWING, J.: Neoplastic Diseases. 3rd edition, 1928, 37.
JACOBI: Quoted by Nicolich.
JUNGHANNS, H.: Eine Krebesstatistic Ueber 35 Jahre. Zeitschr. f. Krebsforschung 1929, XXIX, 623.
KAPSAMMER: Quoted by Wagner.
KÜSTER: Chirurgie der Nieren. 1896-1902, 561.
LUBARSCH, O.: Handbuch der Speziellen Pathologischen Anatomie und Histologie. Vol. 6, part 1, 607.
MAJOR, R.: Multiple Primary Malignant Tumors. Johns Hopkins Hospital Bulletin, 1918, XXIX, 223.
MURRAY, J. A.: Multiple New Growths. Lancet, 1927, CCXIII, 800.
NICOLICH, G.: Ueber Beiderseitige Nierengeschwülste. Zeitschr. f. Urologie, 1929, XXIII, 477.
ORR, J. W.: Multiple Malignant Neoplasms. Jour. Path. and Bact., 1930, XXXIII, 283.
PAUL: Quoted by Nicolich.
PUHR, L.: Ueber die Multiplizität der Geschwulste. Zeitschr. f. Krebsforschung 1926, XXIV, 38.
SEECOF, D. P.: Multiple Primary Malignant Neoplasms: Jour. Cancer Research, 1924, VIII, 213.
SIEBKE, H.: Ueber Multiple Carcinome. Zeitschr. f. Krebsforschung, 1926, XXIII, 66.
TASCHIRO, N.: Zur Kasuistik der Multiplen Primären Malignen Tumoren. Zeitschr. f. Urologie, 1924, XVIII, 209.
TAYLOR, M. L., and TEACHER, J. H.: A Series of Double Malignant Tumors. Jour. Path. and Bact., 1910, XIV, 205.
WAGNER, P.: Zur Kasuistik primärer doppelseitiger maligner Nierentumoren. Folia Urologica, 1912, VI, 619.
WOOLLEY, P. G.: Notes on Multiple Primary Malignant Tumors. Bost. Med. & Surg. Jour., 1903, CXLVIII, 4.
YOUNG, R. A.: On Multiple Primary Malignant Growths. Arch. Middlesex Hosp. 1904, III, 165.

DISCUSSION

Dr. William F. Braasch (Rochester, Minn.): The pyelogram, which was shown by Dr. Hunt in the case of actinomycosis, was one of unusual interest. It would be almost impossible to identify actinomycosis in a pyelogram, because the resulting deformity would easily be confused with various renal lesions, such as renal neoplasm (and the pyelogram shown was quite typical of tumor deformity), cystic disease, tuberculosis, renal carbuncle, and so forth. Extensive carbuncle of the kidney may cause deformity of the calices, with elongation and tapering, quite suggestive of renal tumor.

I should like to add one more case of unilateral renal actinomycosis which was recently found at postmortem at the Mayo Clinic, which ruptured spontaneously into the lumbar sinus. Dr. Hunt has called attention to the fact that in existing sinus of the kidney, either postoperative or not, we should always rule out the possibility of actinomycosis.

The paper of Dr. Caulk was a very interesting one. It seems to me that one of the most interesting problems that we have before us now is that of determining the possibility of spontaneous healing with renal tuberculosis. This question frequently arises in cases of supposed unilateral renal tuberculosis when guinea pig inoculations of the supposed well side are reported positive. This occurs in a surprisingly large percentage of cases, and where these patients have been followed up years later, we have found that many of them have recovered completely symptomatically, as well as in every other way.

There are two possible theories. One is that the evidence of infection in the supposedly well kidney was due to contamination of the ureteral specimen by regurgitation from the bladder, and second that it is the result of spontaneous recovery from actual tuberculosis. It is impossible for me to believe that there is so large a percentage of cases of spontaneous recovery from renal tuberculosis without much of any pathologic evidence existing to prove it. In my opinion the clinical evidence of infection is misleading and is the result of ascending contamination from the tuberculous bladder, permitting regurgitation of tubercle bacilli in the ureteral specimen without any other finding. It is a most

interesting subject and data will undoubtedly be brought forward in the near future to substantiate one theory or the other.

I differ with Dr. Kretschmer in the statement that there is no difference in the incidence of tuberculosis, stone or tumor in either sex. It has been our experience that the incidence of these lesions referred to is almost two to one in the male.

PROFESSOR A. VON LICHTENBERG (Berlin, Germany): Concerning renal tuberculosis, when you examine the cases with intravenous pyelography you can see reasons why there could be ascending tuberculous involvement of the ureter from the bladder. Pictures with intravenous pyelography show, in the lower part of the ureter, dilatation, and it is perfectly easy to imagine how tuberculous ureters ascend into a well kidney and give findings of tubercle bacilli in the urine.

The operative handling of renal carbuncles is difficult to decide upon, particularly in deciding whether the renal carbuncle itself is the only infection in the body or whether it is merely the kidney localization of even more important infection through the rest of the body. In view of this it is difficult to decide whether nephrectomy should be done, or whether enucleation, or whether operative drainage.

If the condition tends to be chronic, conservative treatment can be employed. When it is a new infection and in an acute stage, it is difficult to refrain from nephrectomy, considering the great risk the patient might undergo if you pursue this plan. There are many cases that I have seen in which, in spite of early nephrectomy, the patient has died from a general infection.

In view of the rarity of this condition and the various phases of it, it is difficult to give operative principles to cover every case. Therefore, each case should be studied and judged on its individual indications.

Concerning the mechanism of the development of these kidney infections, we know practically nothing. It is very difficult to understand why in some cases a carbuncle and in other cases a local abscess occurs, and in a third case still another kind of infection, and until we understand the mechanism of development it will be very difficult to state definite surgical principles of handling the cases.

DR. WILLIAM E. LOWER (Cleveland, Ohio): I should like to discuss Dr. Caulk's paper particularly because the question of

renal tuberculosis interests me very much. I think it is a general rule that primary destructive lesions, if operable, should be removed as early as possible, but I am not sure that that always holds true for tuberculosis of the kidney. I think a general review of our cases will show that the most progress has been made in those cases in which there is a very marked lesion of the kidney, either caseation or a large abscess, rather than in those cases in which there is only a small area of tuberculosis. In other words, I have seen some patients in whom the lesion in the kidney has not been very pronounced go on without operation and tuberculous meningitis and tuberculous peritonitis develop. Even when these patients have been operated upon this has followed, but I have never seen it occur in cases in which there was very marked caseation of the kidney, or a large abscess.

I recall one patient who had tubercle bacilli in the urine continuously after operation, for twenty-five years, but most of the time has been very comfortable. Sometimes she has had a little flare-up in the bladder. She has borne several children and no complications have occurred, but we can always demonstrate tubercle bacilli in the urine. Whether these bacilli come from the part of the ureter that is left, or from certain lesions in the bladder, or from the other kidney, I am not prepared to say. I feel quite sure that the rule that one should operate on a tuberculous kidney as soon as the diagnosis has been made, if the lesion is a small one, is incorrect. I feel rather that it is best to wait to see what local protection the patient is going to develop around that kidney, and then later take care of it.

Caseous kidneys should be removed, because I have seen bladder symptoms follow when there has been marked caseation, but my own observation has been that cases do the best in which there is a well circumscribed lesion of the kidney.

Dr. David W. MacKenzie (Montreal, Canada): In discussing Dr. Caulk's paper, I want to accentuate practically what both Dr. Caulk and Dr. Lower have said about operations on the early, acute cases when things are not localized. The older ones seem to have developed some form of resistance and do better.

In a case we had not long ago of a very early lesion, with multiple acid-fast bacilli in the urine, and a definite, small, more or less angry lesion in the kidney, about a week following opera-

tion, the patient developed some rigidity of the neck. He slowly recovered, went home, and returned to us with absolute paralysis of the lower limbs and the sphincters. He was operated on in the Department of Neurological Surgery, and showed a definite acute spinal lesion.

DR. CHARLES M. MCKENNA (Chicago): I should like to ask Dr. Caulk how many, out of the 108 patients he operated on, showed tuberculosis on the opposite side within twelve months.

DR. CAULK: Seventy-seven per cent were entirely well and twenty-three per cent had tuberculosis later.

DR. MCKENNA: Speaking from my own experience, I am in favor of conservative surgery in renal tuberculosis. At the Municipal Tuberculosis Sanitarium in Chicago, where we have a large amount of material for study, most of the cases we examine are unilateral for the very good reason that the other kidney has been removed.

I think Professor Medlar, formerly assistant pathologist at the University of Wisconsin, stated that Dr. Caulk of St. Louis, in an article writen in 1920, made the statement that there has never been reported a case of healed renal tuberculosis. Dr. Medlar, in an article later, reported and showed a number of healed tubercles in the kidney. I might add that Medlar's work was on the human and he showed to our satisfaction that renal tuberculosis does heal.

It is true that bladder irritability is one of the most common symptoms. In our experience it is one of the first symptoms. I believe it was Rovsing who pointed out the value of cystoscopy in making a diagnosis of renal tuberculosis. He noted that there was usually an irritation or an inflammatory condition around the ureteral orifice, corresponding to the infected kidney. That sign in a diagnosis in our opinion does not always hold true. We have made many, many cystoscopies in cases where we knew the patient was suffering with renal tuberculosis and we had already collected urine showing tuberculosis on both sides and in others where it was only unilateral, and, I might add, in a number of those cases no inflammatory condition or cystitis could be seen around the ureteral orifice.

The whole question of the management of renal tuberculosis in my opinion is a correct diagnosis. In other words, one must

be satisfied that he is dealing with a unilateral and not a bilateral lesion.

I think if we would use as much care in the management of a patient suffering with tuberculosis of the kidney before a nephrectomy is done as we do after a kidney has been removed and the patient develops the same condition on the other side, we would go a long way towards improvement in this condition.

I particularly want to second what Dr. Lower had to say about tuberculosis of the kidney. We have seen so many of that class of case which he has shown very well. I should like to point out one case that we saw which is described as follows:

A young woman, twenty-seven years of age, had been dilated for a stricture of the left side. This patient had suffered with some frequency over a period of three years. Many, many guinea pig inoculations had been made from the urine, all of which were negative for tuberculosis. One morning, about six o'clock, she developed a terrific hemorrhage from the bladder. It was impossible to make a cystoscopic examination at the time. Everything was done to stop the hemorrhage, including a blood transfusion. After persisting for some time, we were able to introduce a catheter into both ureters. On the left side, she had a pure culture of tuberculosis; the other side was perfectly clear. The patient continued to bleed. There was only one way to stop it and that was a nephrectomy, which was done very easily under gas anesthesia. She made a very stormy convalescence. About three months later she developed a hemorrhage from the opposite side and finally died of tuberculous meningitis. I might add that on the kidney removed there was a lesion in the upper pole about the size of a dime that had broken into the upper calices and another about the same size, 2 cm. away. The rest of the kidney remained perfectly normal in appearance.

I point this case out to show how necessary it is to be conservative in the management of renal tuberculosis. In this case there was no other way out of it. The kidney had to be removed to prevent hemorrhage, but it illustrates very well the point that she had a lesion equally as bad on the other side.

Dr. Gilbert J. Thomas (Minneapolis): I think Dr. Caulk's paper concerning the question of tuberculosis of the kidney is very refreshing from several points of view. In the first place, I think we must remember that tuberculosis of the kidney is not

a local disease, but is merely a local manifestation of a general disease. The tubercle bacilli gain entrance to the body through the chest cavity, and then into the blood stream. The primary lesion is in the chest cavity, either the lung or the peribronchial gland, and the kidney is a secondary manifestation or a local manifestation of a general disease.

We must keep this fact in mind when we are making our investigations and when treatment is advised.

Concerning bilateral lesions of the kidney, we have always felt that it is just as easy for the tubercle bacilli to get into both kidneys as it is into one. The renal arteries are about the same. Then the question comes up as to why the tuberculosis develops in one kidney and why it does not develop in the second. Why do we find a carbuncle in one kidney, and none in the other, when we know in most instances that organisms will be found in the blood stream if the blood culture is obtained at the right time? In both instances it is probably some lowered resistance in one kidney.

The question of diagnosis is tremendously important because it is very difficult in the early case. One can examine the urine repeatedly and find tubercle bacilli one time, and not another. Many observers think that this supposed error is due to regurgitation or reflux up one ureter. We explain the occurrence and non-occurrence of tubercle bacilli in the urine by a lesion near a tubule, which is not a destructive lesion, but an inflammatory one produced by tuberculosis which ulcerates into the tubule. During activity this permits tubercle bacilli and pus to get into the urine. Then the lesion is temporarily controlled and may heal. Other small lesions may occur. If you go further with this sort of lesion, you may get destruction or phthisis of the kidney; in which instance tubercle bacilli and pus are found in the urine every time it is examined. This type of lesion will not heal.

What are we going to do with a destructive lesion that is unilateral? We believe that tuberculosis of the kidney is a local manifestation of a generalized disease and it is possible for both kidneys to be infected at the same time. Therefore, when we have a noticeable, easily demonstrated phthisical destruction of one kidney, the question is whether the other kidney is eliminating tubercle bacilli. The second kidney may have an ulcerative

lesion that does not show on the pyelogram. This lesion may eliminate tubercle bacilli when the ulceration is in the tubule, and may not eliminate bacilli when the ulceration is controlled or healed.

I think it is necessary, therefore, in trying to determine whether or not surgery is the most desirable type of treatment, to be absolutely sure that there is not a lesion on the other side. If you are not sure, even if there is the small destructive lesion so ably described by Dr. Lower, it is advisable to wait until the patient develops resistance. That is what Dr. Lower was speaking of. If a patient has a tuberculosis of the lung, the sunshine, rest, and medicine that you prescribe, all help to develop resistance against tuberculosis. The resistance that we develop in the kidney, even when a destructive lesion is present, will control that lesion. Its course may be followed for years. It will be a little lesion that does not heal, but does not get any bigger because the patient has enough resistance against tuberculosis to control it.

Dr. Lower mentioned a point in his experience regarding the removal of a large destroyed kidney. He states that he did not get complications following this operation. Why? Because the patient had developed resistance against tuberculosis.

What is to be done with the patients that Dr. Caulk mentioned who have the incurable, terrible bladders? If the patient has enough resistance, the lesion in his bladder will heal, otherwise it will not. We are dealing with the local manifestation of a general disease. We must not stop in taking out the kidney, but must put that patient to bed for six months. When we remove a kidney from a patient in our sanitarium, our invariable rule is that the patient must be kept in bed for six months. We never get a big gaping kidney wound which takes six weeks to heal, because before operating we determine whether the patient has resistance, and, secondly, we make sure that he can hold that resistance, in spite of surgical trauma, until his wound is healed.

DR. ALEXANDER RANDALL (Philadelphia): I think it is awfully interesting to think that today this discussion, which has been a rather perennial one, is probably going to be answered within the next few months when we are more at home with and more generally using intravenous pyelography.

Within the month we had a young boy of twenty-odd years

who, according to our accepted today's method of study, was an ideal patient for a nephrectomy for tuberculosis. His cystoscopic picture was quite characteristic; his differential functional tests spelled a unilaterality of the disease. The picture was one of what in the past we have thought was unilateral renal tuberculosis, and surgery indicated.

Our surprise was tremendous, when doing intravenous pyelography on him, to find a bilateral picture, both ureters dilated, both pelves dilated, and apparently it was impossible to differentiate on that investigative method which side was the more involved.

I regret I did not bring the picture with me, but I have a feeling that between now and the time when, let us say, our own transactions are published, there is going to be a tremendous insight into this problem which has been before us year after year, by this new method of investigation.

DR. JOHN R. CAULK (St. Louis): I appreciate this free discussion. I expected it and cherish it.

I agree with most of the things that were said. I naturally believe with all the men in this Association that men should investigate the kidneys beforehand very, very carefully. I personally would never think of removing a kidney unless I had repeatedly studied the capacity of the kidney or whether the other kidney was infected or not, to the best of my ability.

We have to discriminate between tubercle formations or ureteritis or ulcerations of the bladder and the old chronic ulcerative caseous lesions which we get in the kidney. We don't get these kidneys early, at least I don't. They have been going on for years, usually. The average duration of symptoms in our cases was two years and nine months, and naturally the long time it takes to infect the bladder and the sinus of the kidney makes us believe that those kidneys were infected many, many years before that. So we have walled-off cavities which do not have a tendency to heal as tubercles here and there in the urinary tract will heal. It is an entirely different process.

In these cases I am still convinced that nephrectomy is the method of choice. I do believe that we must protect the bladder from more and more invasion and infiltration and invalidism to the patient.

I feel, from an analysis of my patients, that the more acute

the lesion, the more rapid are the healing and the relief of symptoms. The old chronic cases that have been present for a long, long time, with invasion of the bladder, are the ones that have been resistant and more stubborn in healing.

Dr. MacKenzie mentioned the bladder. We have had three cases in this series with persistence of symptoms due entirely to contractures of the neck. Two of them were entirely relieved by punch resections.

I should like to put on record a case in discussing Dr. Sanford's paper on bilateral renal tumors. In 1912 I saw a case of bilateral renal carcinoma of the kidney. The patient had a hematuria, left renal bleeding, and three cystoscopies. I left town, and one of the general surgeons in the early days, who was still looking in the bladder, found bleeding from the other side. In those days cystoscopes weren't so good, and I criticized him and told him he didn't know one side of the bladder from the other. He said he thought he had seen it coming from the right kidney. We made a cystoscopic examination of the patient, and he was bleeding from the left. I removed the left kidney with papillary carcinoma of the renal pelvis. There was relief from the hematuria. He left the hospital, and came back three months later with hematuria, uremia, death—adenocarcinoma of the other kidney.

FAT EMBOLISM FOLLOWING PYELOTOMY FOR STONE WITH LEUKOPLAKIA OF THE RENAL PELVIS

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The term fat embolism is understood to mean the presence, in the blood, of free neutral fat in droplets large enough to take the fat stains. The normal blood, even in digestive lipemia, obviously does not fulfill these requirements, although it has been stated by Paul and Windholz[23] that blood fat normally may range as high as 2 per cent.

Pathologic lipemia has long been considered a result of trauma, for the most part, and indeed some observers consider this factor alone as a cause. Thus Lehman and Moore[21] cite from the literature the following quotations: "In order to permit the entrance of fat into the circulation in amounts even to approach the amount of free fat in the blood stream, in pulmonary fat embolism, there must be an injury to the fatty tissue, and, second, a break in the continuity of the blood stream . . . Fat embolism is an acute circulatory disturbance caused by trauma . . . Fat in minute particles of emulsification or saponification plays little if any important rôle in the production of embolism." These authors[21] agree that there is no doubt of the occurrence of traumatic fat embolism, but further state that trauma is not the only cause of fat embolism. They recognize that traumatic etiology can readily be demonstrated clinically and experimentally, following mechanical disturbances such as fractures, operations on soft parts and on bone and concussions of the body. Carrara[8] reports fat embolism present at necropsy in cardiovascular-renal disease and in extensive burns, Catsaras[9] in postinfluenzal pneumonia, Grondahl[16] in eclampsia, diabetes and phosphorus poisoning and Winogradow[35] found it occurring regularly in potassium chlorate poisoning. Single authentic reports of its occurrence in many other conditions, not associated with trauma, have been recorded.

Trauma therefore is not the cause of all fat embolism and not necessarily the cause of all free fat in the blood of cases associated with trauma.

Lehman and Moore,[21] working with intravenous ether in animals, satisfactorily produced fat embolism; it was especially evident when carried out in the presence of digestive lipemia. The ether in the blood stream takes into solution the circulating emulsified droplets; as the ether vapor passes into the alveoli of the lungs, the ether vapor tension in the blood is lowered to a point at which the fat comes out of the solution as free fat. They further conclude experimentally that the introduction of ether by inhalation is probably more effective in producing embolism than by intravenous injection.

The danger of prolonged ether anesthesia clinically is accordingly apparent; the danger being relatively increased by an insufficient preliminary starvation period.

Scriba[29] has pointed out from experimental observations that a drop of fat could pass through the lungs and back into the general circulation. The greatest amount, however, is collected in the pulmonary capillaries, which fact justifies the usual necropsy procedure of always studying microscopic sections from lung tissue where this accident is suspected. The fat that passes through the lungs, into the arterial circulation, in part forms emboli in other organs and is in part excreted by the kidneys, or carried out of the body by phagocytes in the sputum, feces and bile.

The lungs frequently show edema, more commonly hemorrhage, hemorrhage infarcts, acute emphysema and the presence of fat droplets in the larger vessels, while microscopic sections reveal fat emboli in the larger and smaller vessels, as a rule evenly distributed throughout these organs. The heart, kidneys, liver, spleen, pancreas, adrenals, thyroid, skeletal structures and brain may be quite similarly involved. The associated lesions of the brain and cord are considered most important, such as arterial and capillary anemia, perivascular hemorrhages, capillary apoplexies and small areas of degeneration. Varying amounts of tissue infarction without inflammation are found, where life has been sustained sufficiently long to produce it.

Warthin,[31] who has made an exhaustive study of the subject, considers two clinical types, namely the pulmonary and the

cerebral. The pulmonary type is characterized clinically by dyspnea, cough, cyanosis, pulmonary edema and hemorrhage to the point of hemoptysis. These symptoms may develop at once or appear insidiously. Death may take place almost at once or the patient may live for several weeks or even recover. Restlessness, headache and stupor may be the first symptom, to be followed by marked respiratory distress. The heart rate is increased, the rhythm may be irregular and the tension low and associated with varying degrees of epigastric and precordial pain. The temperature may be low or high, usually low at first and rises gradually. This is in accord with the findings of Grondahl[16] but contradictory to Scriba's[29] observations that the temperature is always low.

The cerebral form usually manifests itself after an intervening period, often three to eight days following the cause. Here the pulmonary symptoms are less prominent. Uneasiness is usually a pronounced feature associated with or followed by headache, drowsiness, mental cloudiness, stupor, hallucinations or delirium and in severe cases passing into a comatose state. There is loss of reflex excitability and there may be definite tremors, convulsions or paralysis. Signs of increased intracerebral pressure, such as choked disc, slow pulse and rigidity of the neck, are invariably absent. Respiratory symptoms may supervene.

The condition is not frequently diagnosed before necropsy. In Warthin's[31] twelve fatal cases the condition was diagnosed once antemortem, the diagnosis of the others being shock, heart failure, acute cardiac dilatation, cerebral hemorrhage, pneumonia, sepsis, insanity and alcoholism. To this list should be added delirium tremens, sunstroke or heat exhaustion, diabetic and uremic coma, as confusing diagnosis.

In general the diagnosis should be based upon those considerations that are peculiar to it alone. When clinical conditions indicate it, it should be looked for after damage to bones containing marrow, concussion, orthopedic manipulations of atrophic bones, severe burns or any other surgical or accidental manipulation of tissues containing large quantities of fat. It has been repeatedly said that there is no clinical correspondence between the apparent tissue injury and the degree of resulting lipemia; the effect depends upon the amount and distribution of the fat in the blood stream. Specific search should lead one to

a thorough and repeated examination of the urine for fat. Positive findings are intermittent but the urine may have a layer of fat or only large fat droplets. Warthin[31] presents as a new diagnostic sign the finding of fat droplets or phagocytes containing fat in the sputum. Ophthalmoscopic examination of the eye grounds for free floating fat in the blood stream may be of value as well as the actual determination of fat content from venous blood or its identification in droplet form on the surface.

As has been intimated, the clinical course of this condition may be rapid or slow, but in well developed cases, with appreciable signs and symptoms, the prognosis is grave. Undoubtedly many cases recover from conditions diagnosed as some other condition, such as shock, collapse or concussion.

The treatment obviously should be directed toward its prevention by careful attention to a sufficient starvation period preceding ether anesthesia, absolute rest and avoidance of unnecessary moving of the patient suffering from trauma either accidental or surgical.

Since relatively few cases are recognized antemortem, active treatment necessarily has not been standardized through individual experience, but should consist of means of lessening the free fat in the blood stream and the proper use of stimulants. The intravenous injection of calcium carbonate has been used experimentally by Czerny[10] with relief of dyspnea but no decrease in mortality. He advises venesection followed by intravenous calcium carbonate. Schanz[28] suggests the intravenous administration of normal salt as of value and describes its successful use by infusion in eight of ten cases of fat embolism following orthopedic manipulations. There have been some exceptions to the diagnosis of Schanz's cases. Drainage of the thoracic duct has been done experimentally and clinically with success, the purpose being to prevent fat, taken up by the lymphatics, from entering the general circulation. Where feasible, proper drainage of traumatized tissues is indicated to prevent, in a measure, further entrance of fat into the circulation.

Together with these active measures must be considered cardiac stimulants, administration of oxygen and artificial respiration.

With these general preliminary remarks we wish to present

the clinical and necropsy findings of a white male who died of fat embolism following operation for stone of the kidney, the kidney pelvis being the seat of extensive leukoplakia.

T. Z., male, aged thirty-three years, entered St. Luke's Hospital December 29, 1929, complaining of a constant, dull, aching pain in the right kidney region posteriorly of about four weeks' duration. Cloudy urine was known to have been present for a year.

He was wounded by shrapnel about the right knee joint dur-

Fig. 1. (Left) Plain roentgenogram showing large stone in right kidney pelvis (reversed).

Fig. 2. (Right) Right pyelogram completely effacing shadow of Figure 1. Very little kidney destruction.

ing the World War and the resulting osteomyelitis necessitated seven surgical procedures to effect a cure, which caused a bony ankylosis of this joint. There had been no symptoms referable to this structure for over a year.

He was a man of good habits, was not an alcoholic, and had no complaints other than those mentioned.

The physical examination revealed only an ankylosed right knee about which were several healed surgical incisions. The liver was palpable but the abdomen contained no other palpable masses.

The blood contained 4,700,000 red cells and 14,000 leukocytes per cubic centimeter, while the hemoglobin was 88 per cent.

Coagulation time was four minutes. The blood pressure was 136 systolic and 70 diastolic. The temperature was normal.

Cystoscopy, December 29, revealed no urethral findings and the bladder capacity and tolerance were good. Urine obtained from the bladder was very cloudy. The bladder was normal to observation excepting for chronic edema immediately about the right ureteral orifice. Number 6 F. catheters passed readily to each kidney pelvis and clear concentrated urine was collected from the left kidney and cloudy dilute urine from the right kidney.

Phenosulphonephthalein given intravenously appeared in four minutes in excellent concentration from the left kidney and in five minutes in poor concentration from the right kidney.

Plain roentgenograms revealed a large shadow in the region of the right kidney pelvis (Fig. 1). A right pyelogram effaced this shadow and further showed dilatation and clubbing of the calices to a moderate degree, associated with a tortuous and slightly dilated ureter (Fig. 2).

Microscopic and cultural findings: There were no acid-fast organisms found by smear in any specimen of urine.

The bladder urine contained innumerable pus cells and cultures revealed white staphylococci and colon bacilli.

The urine from the left kidney contained only a few red cells and was sterile on culture, whereas the right kidney contained many red cells and pus cells and on culture presented white staphylococci and colon bacilli.

The diagnosis was accordingly made of stone of the right kidney pelvis associated with a chronic mixed infection. Surgical removal of the stone was decided upon.

Pyelolithotomy was performed January 7, 1930, under ether anesthesia.

The operation was originally scheduled for January 6, 1930, and the patient was brought to the operating room and an ether anesthetic started, but it was soon apparent that he had recently eaten, so the anesthetic was stopped after five minutes and the patient was returned to his ward. Investigation revealed confusion in orders and that the patient had had the usual ward diet two hours before the attempt at anesthesia. He had no immediate disturbance, at least, from this experience so was properly prepared and readily anesthetized the following morning.

The patient was robust, but not fat, there being only an ordinary amount of perirenal fat present. The kidney was readily delivered revealing conditions suitable for pyelotomy. This was done and a large white stone removed which was intact, having no rough or broken edges. Finger exploration of the pelvis discovered no other stones. There was no apparent hemorrhage after the kidney was replaced. This was watched for specifically

for some time as it is our custom in such procedures. The pelvis was not sutured, but a large soft cigarette drain was placed immediately under it and brought out of the upper angle of the incision. A second similar drain was placed along the course of the upper ureter and brought out alongside the first one. Closure was made in three layers in the usual manner.

During a stay of nine days in the hospital prior to operation, the temperature had at all times been normal, the pulse ranged between 72 and 82 per minute and the respirations between 18 and 22 per minute. Following the surgical procedure there was an intermittent temperature. The low temperature rarely touched normal during the day. The high temperature reached 100.2 Fahrenheit the first day and gradually increased to 106.0 Fahrenheit on the sixth day, just before exodus, while the pulse rate was never under 100 during this period. The pulse rate varied considerably without apparent cause, frequently reaching 120 while the patient was quiet and comfortable; just before exodus it was 140 per minute. There was very little if any increase or change in character of the respirations until a few hours before exodus, when they were recorded as 40.

The outstanding feature of the entire postoperative period was the marked restlessness and anxiety of the patient. This, at first, was thought to be caused by a quite persistent abdominal distention which was relieved on the third day by enemas and an injection of surgical pituitrin, but the state of mental unrest was not noticeably changed. Sleep was only at short intervals and this usually following sedatives. The patient moaned almost constantly and repeatedly asked every one entering his room to do something for him, giving no specific complaint or demand in any instance.

The fluid intake and output was satisfactory throughout and there was no evidence of hemorrhage or infection about the drains or incision. Urine draining on the dressings never gave more than a pink tinge and for the most part was clear. The voided urine was blood stained for two days only.

There were no symptoms referable to the lungs and repeated examinations gave no findings.

Nine hours before death the patient was quite comfortable, he had just finished his best postoperative day, when he very rapidly went into severe shock, became cold and clammy, the radial pulse could not be felt, respirations became rapid and labored and the rectal temperature was 106.0 Fahrenheit. He talked incessantly but irrationally. The blood pressure was 90 systolic and 60 diastolic. This picture was practically unchanged until his exodus nine hours later, although intensive stimulation was given.

Necropsy was performed by Edwin F. Hirsch, pathologist to St. Luke's Hospital.

Before the body was opened we gave Dr. Hirsch a résumé of the clinical facts and he immediately suggested that fat embolism was the probable cause of death.

The essential pertinent findings and anatomic diagnosis only are included.

Anatomic Diagnosis.—Lipemia; multiple petechial hemorrhages of the serous membranes; recent surgically drained pyelotomy wound; recent extension hemorrhage into the perirenal fat tis-

Fig. 3. Photomicrograph (X 120) of lung tissue showing large droplets of fat in larger vessels and completely plugged capillaries.

sues; slight hemoperitoneum; marked cloudy swelling of the myocardium, liver and kidneys; fatty changes of the liver; right nephrolithiasis; right chronic catarrhal pyelitis and ureteritis; leukoplakia of the right renal pelvis; diminished lipoid substance of the cortices of the suprarenal glands. Head, neck and trunk examined.

About the right kidney was a recent retroperitoneal hemorrhage reaching from the right lobe of the liver to behind the ascending colon. Minute fat droplets coated the surface of the pulmonary vessels. The lining of the right ureter was pale white and slightly granular. Considerable disarranged fat and dark

purple blood clots were adherent to the right kidney. The capsule stripped with some difficulty. The lining of the renal pelvis was reddened, in the upper portions rough and one of the calices was a yellow-white concretion 6x4x2 mm. A firm dark red blood clot protruded into the lumen of the pelvis through the pyelotomy opening. This clot was continuous with clots of blood in the fat around the renal pelvis.

Just above the opening in the pelvis there was a round pearly white wrinkled region 1.2 cm. in diameter, elevated 1 to 1.5 mm. above the mucosa.

Fig. 4. Photomicrograph (X 120) of kidney pelvis through an elevated white area. Leukoplakia.

In the lumens of some of the vessels of the cerebral cortex were droplets that stained with Scarlet R. Sections of formalin fixed lung tissues were stained with Scarlet R. and in the lumens of many small blood vessels and capillaries there were droplets of fat (Fig. 3).

The white plaque in the renal pelvis was like epidermis. The surface epithelium resembled in minute detail the squamous epithelium of the skin (Fig. 4).

A consideration of the factors entering into this case brings forward two outstanding features as having possible etiological significance: First, an attempt at ether anesthesia at the height

of digestive lipemia, and, secondly, a quite marked hemorrhage into the perineal fat. While some bleeding into the draining area occurred it was for the most part not connected with this area, but extravasated throughout the fatty capsule and under the peritoneum covering the liver and ascending colon. This occurrence being possible only under considerable pressure makes for ideal conditions for the entrance of free fat into the circulation. Perhaps a wide opening of the incision, to promote better drainage would have been of value, but inasmuch as urine was draining profusely about the drains at all times and that the general condition was not suspected, this was not considered.

As judged from an analysis of the literature this would be classed as a case of fat embolism of the cerebral type.

BIBLIOGRAPHY

1. Bantin, C. F.: Diabetic Lipemia Retinalis and Fat Embolism, Jour. A. M. A. 86:546, 1926.
2. Bergeman: Berl. Klin. Wochschr., 47:1112, 1910.
3. Bissell, W. W.: Surg., Gynec. & Obst., 25:8, 1917.
4. Bissell, W. W.: Jour. A. M. A., lxvii:1926-1927; 1916.
5. Bloor, W. R.: Jour. Metab. Research, 4:549, 1923.
6. Buerger: Vrtljschr. f. gerichtl. med., 39:159, 1910.
7. Caldwell, G. T., and Huber, K. L.: Surg., Gynec. & Obst., 25:650-663, 1917.
8. Carrara: Friedreich Bl. f. gerichtl. med., 49:1898.
9. Catsaras, J.: Presse med., 28:618, 1920.
10. Czerny: Berl. Klin. Wochschr. 12:593-605, 1875.
11. Dunn, J. S.: Jour. Path. & Bacteriol., 27:425, 1924.
12. Elting, A. W., and Martin, C. E.: Am. Surg., 82:336, 1925.
13. Fritsche: Deutsche Ztschr. f. Chir., 107:456, 1910.
14. Gauss, H.: Pathology of Fat Embolism, Arch. Surg., 9:593, 1924.
15. Gold and Loffler: Ztschr. f. d. ges. exper. med., 38:153, 1923.
16. Grondahl: Deutsch, Ztschr. f. Chir., 111:56, 1911.
17. Hauser: Ergebn. d. allg. Pathol. u. Path. Anat., 19:147, Part 2, 1921.
18. Koch, Herman: Deutsche Ztschr. f. Chir., 186:273, 1924.
19. Landois: Ergeben d. chir. u. orthop., 16:99, 1923.
20. Le Count and Gauss: Trans. Chicago Path. Soc., lx:251-258, 1915.
21. Lehman, Edwin P., and Moore, Robt. M.: Fat Embolism. Including Experimental Production without Trauma. Archives of Surgery, Vol. 14, 621-662, 1927.
22. Mott and Uno: Proc. Royal Soc. Med., xv.
23. Paul, F., and Windholz, F.: Mitt. a. d. Grenzgeb. d. Med. u. Chir., 38:614, 1923.
24. Porter: Amer. Jour. of Phys., xxii:282, 1910; Boston Med. and Surg. Jour., 176:248, 1917; Am. Jour. Physiol., 71:277, 1925.
25. Porter, Marks and Swift: Am. Jour. of Physiol., xx:444-449, 1907.
26. Ribbert: Cor. Bl. f. Schweiz. Aerzte, 24:457, 1894.
27. Ryerson, E. W.: Fat Embolism, Jour. A. M. A., 67:567, 1916.
28. Schanz: Zentrbl. f. Chirur., xxxvii:1910.

29. SCRIBA: Deutsche Ztschr. f. Chir., 12:118, 1879.
30. SUTTON, G. E.: Am. Surg., 76:581, 1922.
31. WARTHIN, A. S.: Internat. Clin., 4:171, 1913.
32. WEGELIN, C.: Schweiz. med. Wchnschr., 53:133, 1923.
33. WILMS: Semaine med., 30:138, 1910.
34. WINKLER: Ztschr. f. orthrop. Chir., 45:616, 1924.
35. WINOGRADOW: Virchows, Arch. f. Path. Anat., 190:92, 1907.
36. ZIENKE, E.: Deutsche Zeitschr. f. d. gesammt Gericht med., 1:193-203, 1922.

A SUCKER FOR EXTRACTING SMALL STONES FROM KIDNEY CALICES

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The great difficulty in removing small stones, fragments of stone, and sand from the kidney calices has long been recognized. If small fragments are allowed to remain, they often become the nucleus for the formation of larger stones. Many believe that the quick recurrence of stones following operation is due to small particles overlooked at the primary operation. Even though they may be recognized by the ingenious methods of the roentgenologist, it is often difficult at the operating table to remove small fragments without doing considerable damage to the mucous membrane of the pelvis and calices.

Fig. 1. Instrument used for irrigating calices of kidney and for removing small stones.

For some time we have been using a flexible sucker through which we can irrigate and produce suction. By means of this instrument, small fragments of stone can be washed loose and then sucked out.

This sucker is made of flexible tubing so as to be adjustable to any angle in the kidney pelvis and calices. The tip is made of soft rubber and is shaped much like a leech's sucker; a two-way valve controls the irrigation and suction channels. On several occasions I have been surprised to find the stone firmly held by the sucker so that it can easily be removed from the kidney.

If a stone has been accidentally or purposely crushed, water can be passed through the tube, and then sucked back, bringing

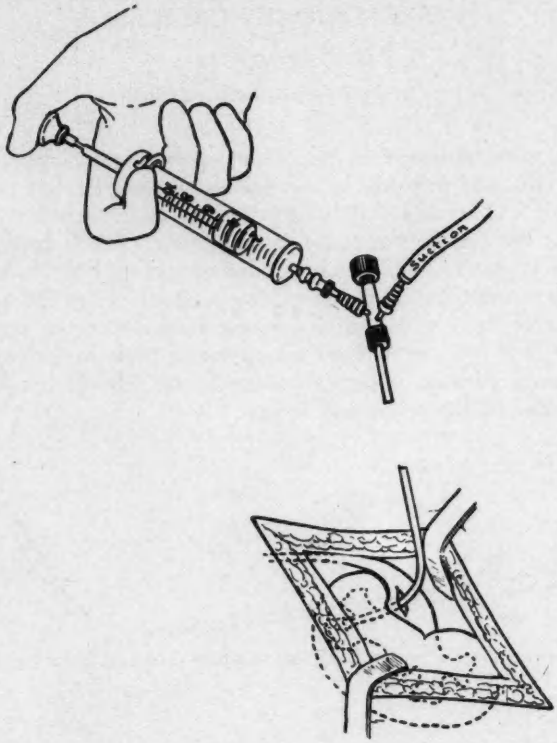

Fig. 2. Schematic drawing showing operation of sucker shown in Figure 1.

with it the small, chipped-off fragments and sand loosened by the irrigation, thereby cleansing the pelvis and calices of all debris.

THE FREQUENCY OF BILATERAL INVOLVEMENT IN "CONGENITAL" HYDRONEPHROSIS

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This paper deals only with that type of hydronephrosis which results from some apparently congenital malformation at the ureteropelvic junction. It has been variously termed idiopathic, primary, and congenital. It is not necessary here to discuss whether the obstruction is due to an anomalous vessel, to an abnormal insertion of the ureter, to a kink or congenital stricture of the ureter, to some motility of the kidney, to some interference with normal ureteral peristalsis, or to a combination of any or all of these factors. There is much disagreement as to the actual causal mechanism but not as to the effect. The resulting hydronephroses seem very similar both as to clinical manifestation and pyelographic evidence. While motility probably has something to do with the production of this type of pelvic enlargement, all cases where this particular etiology seemed to be the main factor have been excluded from the list.

The literature on this particular type of hydronephrosis during the past twenty years is voluminous,—dealing first with the diagnosis; later with the causal mechanism; and during the past eight years largely with surgical treatment. A perusal of nearly 150 articles revealed the fact that very little has been said as to whether the condition is unilateral or bilateral. No article dealing primarily with this phase of the subject was found, and only six writers mentioned in a more or less indefinite way the relative occurrence of the two types. Five text-books do not mention the subject. Another text-book defines this type of hydronephrosis as a "unilateral enlargement of the renal pelvis" and the word unilateral is in italics. Frank and Glas say that bilateral hydronephrosis is rare. Gerarthy and Frantz think that the condition "is more often unilateral." On the other hand White says that "there is always the possibility of the other kidney being hydronephrotic," and Rumpel says that the condition is usually bilateral. Hinman's classification is quite elaborate

and original and it is difficult to determine just how many of his cases would fall into this so-called congenital group, but it is very evident that he finds many of them bilateral. Keyes in the 1924 edition of his Urology quotes Roberts, who found thirteen bilateral and seven unilateral in a group of twenty congenital hydronephroses. Later in the 1928 edition of this same text Keyes says "the majority of hydronephroses are bilateral."

My interest in this phase of hydronephrosis was stimulated by three things:

First: Three patients on whom I had done nephrectomies returned with similar symptoms and a similar condition on the other side. Three similar patients have been seen whose nephrectomies were done elsewhere.

Second: During the past few years I have been struck by the rather large number of cases that seemed to be bilateral.

Third: A casual perusal of the literature seemed to shed very little light on the subject.

Out of a group of 411 cases that showed pelvic dilation of one kind or another eighty-seven cases were found whose findings—especially the pyelogram—seemed to place them definitely in this group. No case was included that did not have one pelvis whose capacity exceeded at least 30 c.c. Pyelograms were made on all but two and these two were found at exploratory abdominal operations. In twelve cases there was no record of a pyelogram or of a measure of pelvic capacity of the opposite kidney. Obviously one could not say whether these twelve cases were unilateral or bilateral and, therefore, they were discarded and the group thereby reduced to seventy-five. In this discarded group of twelve were included the two cases found at exploratory operation.

In the records of these seventy-five cases there is a measure of the pelvic capacity of both pelves in each case. In sixty of them bilateral pyelograms were made. In the remaining fifteen pyelograms were made on the symptom-producing side only. No case was considered to be bilateral unless the opposite pelvis had a capacity of 25 c.c., or more, or unless its pyelogram showed a hydronephrosis of this type. On this basis fifty-three, or 70 per cent, were definitely bilateral, and sixteen, or 21.3 per cent were unilateral. Six, or 8.7 per cent, were borderline cases and probably would be put in the unilateral class. Of the

bilateral, eight, or 11 per cent of the total, or 15 per cent of the class, gave a history of bilateral symptoms. Three of the bilaterals, or 4 per cent of the total, had symptoms only on the side of the lesser pelvis. Of the bilateral cases the pelvic capacity of the lesser pelvis showed the following: thirty were between 25 and 50 c.c.; nine between 50 and 75 c.c.; eighty between 75 and 100 c.c.; 5 between 100 and 150 c.c.; and one between 150 and 200 c.c. Secondary calculi were found in fourteen cases. In one case the calculi themselves were bilateral and in all but two of these fourteen cases the hydronephrosis was bilateral. Of the two, one was unilateral and the other was questionable.

Two rather interesting and maybe significant observations were made in analyzing this group. First, there were five cases of hydronephroses in children and they are all in the unilateral class. Second, as previously mentioned, six patients, on whom nephrectomies had been done returned with symptoms and hydronephrosis of the remaining pelvis. This represents almost a 10 per cent bad risk. In no one of these six cases did symptoms appear in the opposite kidney in less than three years following nephrectomy.

CONCLUSIONS

1. In the so-called congenital type of hydronephrosis both kidneys are involved in a surprisingly large percentage of the cases.

2. This is a further argument for greater conservatism in the treatment of this condition.

BIBLIOGRAPHY

1. BRAASCH: The Clinical Diagnosis of Hydronephrosis. Surg., Gynec. and Obst., 1914, xxi:1180.
2. CHUTE: Cases Illustrating the Cause of Hydronephrosis. Trans. Amer. Assoc. G-U. Surg., 1922, Vol 15, p. 43.
3. FRANK and GLAS: Ztschr. f. urol. Chir., Berlin, 9:274, July 31, 1922.
4. GERARTHY and FRANZ: A Study of Primary Hydronephrosis. Jour. Urol., 1918, Vol. 2, p. 161.
5. HABLER: Hydronephrosis from Accessory Renal Vessels and Its Treatment; f. klin. Chir., Berlin, 122:732, Jan. 27, 1923.
6. HERBST and PALKEY: Fenger's Uretero-Pyelo-Plastic Operation. Jour. Urol., 1930, Vol. 23, p. 23.
7. HINMAN: Hydronephrosis, Lewis Surgery, Chapter 8.
8. JAMESON: Unilateral Hydronephrosis. Jour. Maine M. A., 14:27, Sept., 1923.
9. LUDOWIGS: Hydronephrosis from Compression of the Ureter by Aberrant Vessels. Ztschr. f. urol. Chir., Berlin, 12:250, March 29, 1923.
10. MARION: Hydronephrosis Caused by an Abnormal Vessel. Soc. de chir. de Paris, 49:616, May 8, 1923.

11. MATHÉ: The Rôle of Aberrant Vessels in the Production of Hydronephrosis. Jour. Urol., 1928, Vol. 19, p. 211.
12. PATCH: Brit. Jour. Urol., 1929, Vol. 1, p. 373; Trans. Amer. Assoc. G-U. Surg., 1929, Vol. 22, p. 181.
13. QUINBY: Hydronephrosis. Trans. Amer. Assoc. G-U. Surg., 1922, Vol. 15, p. 43; Jour. A. M. A., Vol. 93, p. 1907; Jour. A. M. A., Vol. 89, p. 841.
14. ROBERTS: Urinary and Renal Diseases, 1872, p. 482.
15. RUMPEL: Origin of Hydronephrosis. Beitr. z. klin. Chir., Tubingen, 126:296, 1922.
16. SARGENT: Pyelo-Ureteroplastic Correction of Enormous Hydronephrosis. Jour. Urol., 1928, Vol. 20, p. 613.
17. STEVENS: Hydronephrosis Due to Obstruction at Uretero-Pelvic Junction. Jour. Urol., 1930, Vol. 23, p. 493.
18. WHITE: Brit. Med. Jour., London, p. 1043-1045, Dec. 6, 1924.

DISCUSSION

Dr. William C. Quinby (Boston): I am very much interested and also very much delighted that Dr. Lower has given us such a splendid demonstration of the "sucker." I have used the same device for a number of years now, especially at operations for renal stone, but as a matter of fact the tube carrying negative pressure has become today, certainly with us, a constant accessory of almost any sort of operation. It has many uses. A number of years ago, four or five, I began using it as an aid in removing stones from the kidney. You will find this reported in a communication which I made to the New York Academy about two years ago.

Our operating suite is piped for negative pressure, but the method which Dr. Lower has suggested here, of the syringe or negative pressure pump on the water system, is of great value where there is no definite vacuum system connected with the operating suite.

The tube can be used for many things. It is of great aid in removing bleeding where sponging will cause the tissues to change their appearance. If, for instance, you are interested in the careful dissection of some lesion within the bladder, it is much better to control bleeding by the negative pressure tube than to do it by sponging, for this acting as a finely divided file or curette continually destroys the surface of the tissues, and causes hyperemia.

The open-ended tube will pick up a stone; in spite of the fact that Dr. Lower didn't have a very good orderly to pull on the syringe, there is no doubt that it will pick up a stone, but frequently one has to reduce the amount of vacuum, because if the suction is too great, one sucks the tissue right into the tube and thereby impedes free motion at the end.

Dr. Alcock's demonstration is really very striking indeed. I have been interested in this condition for a long time now, and although I have never made a record of the number of patients in which the condition is bilateral, nevertheless my present memory is that possibly a sixth or a seventh of the patients have had a bilateral lesion. Usually, however, the lesion on one side is not nearly so far advanced as on the other; but the mere fact that this is a developmental deformity which is fre-

quently bilateral, as he has very clearly brought out, means, of course, all the more forcefully that one must not answer the problem by nephrectomy.

Dr. Hugh Young (Baltimore). Dr. Lower has brought up a very important question. The large percentage of recurrences of renal calculi, which have occurred in every surgeon's practice, has been a source of the greatest disappointment. The inefficiency and incompleteness of the usual operation for kidney stone is one of the most disappointing things in urology. In all long series of statistics, which have been carefully prepared, and in which the ultimate results are known, recurrence of renal

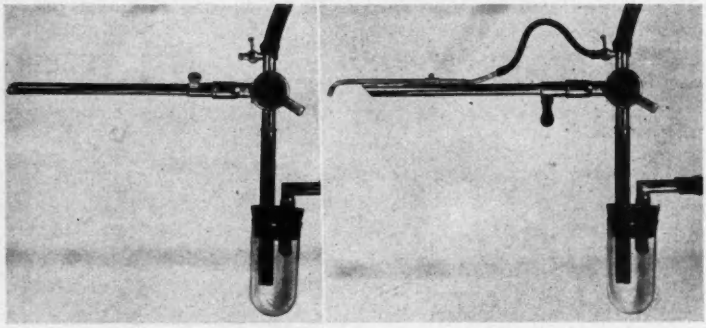

Fig. 1. *(Left)* Young's irrigating and aspirating apparatus with changeable tubes for the evacuation of small renal calculi, fragments and sand.

Fig. 2. *(Right)* Young's irrigating and aspirating apparatus with small sliding tube used for washing fragments out of calices while simultaneous aspirating and evacuation goes on.

calculi happens in over 30 per cent of the cases. It is evident, therefore, that something must be done to improve our statistics. Quinby has advised active suction, and Lower now presents a very ingenious apparatus, in which both irrigation and suction can be quickly carried out.

I have also been working on this subject, and in the machine shop of the Brady Urological Institute I have constructed several instruments with the same end in view. The most recent model is shown in Figure 1. As seen here, the principle of injecting fluid and then rapidly evacuating it by suction is employed. By means of a three-way valve, which operates quickly

under the thumb, injection and suction are easily carried out. A series of tubes of different shapes and diameter to fit the case is provided, each quickly attachable to the main apparatus. In addition to this, an additional tube is provided (Fig. 2), by means of which simultaneous injection and suction can be carried out, the object being to carry this small injection tube into the various parts of the kidney and to wash out small calculi from pockets in which they are lodged while suction is going on, thus making removal of every small calculus or bit of sand more certain.

One of the great reasons for the recurrence of renal calculi is the presence of a dependent pouch, with poor, uphill drainage. There is often a constricted neck, or narrow infundibulum, and the frequent presence of infection, pus and even mucus, readily contribute to the early reforming of calculi. In such cases, particularly where I find a stone in a dependent calix in the lower pole of the kidney, I have for several years resected this portion of the kidney, removing a wedge-shaped piece, and approximating the edges of the renal wound. This operation takes hardly any more time than nephrotomy for the removal of such a calculus, makes certain the completeness of the removal, and also entirely eliminates any possibility of recurrence of calculus in the dependent pouch. It would seem to follow the best principles of surgery in removing the nidus, and thus be a real preventive measure.

Dr. C. E. Burford (St. Louis): I agree with Dr. Alcock that these lesions of hydronephrosis are usually bilateral, but practically all his pictures show the obstruction at the ureteropelvic junction. I did not see a megalo-ureter or a hydroureter in a single one of these pictures, although they seem to be well distended. Mine have practically all been obstructions, either at the bladder neck or at the lower end of the ureter, in children. I cannot account for the obstruction being so high in these cases.

SECOND DAY, MAY 23, 1930

SILENT URETERAL CALCULI*

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The term "silent" has often been applied to renal calculi, denoting calculi, usually of large size, which remain in the kidney causing no symptoms, and which are discovered accidentally. The term has not been applied to ureteral calculi. Yet the following is a striking example.

A male, fifty-four years of age, was seen May 23, 1929. He had been under medical attention for poor gastro-intestinal function and myocarditis for several years. Two months previously he had had an attack of influenza, following which pus was found in the urine, and he was sent to me to ascertain the cause of the pyuria. He had never had an attack of renal colic or any pain in the left side of the abdomen, no urinary symptoms, no hematuria.

Physical examination was negative other than the evidence of an advanced myocarditis.

Cystoscopic examination showed a normal bladder other than a moderate congestion of the trigone and posterior urethra. There was no prostatic enlargement. A catheter was passed to the right kidney. The urine from this side was normal, and the kidney function was normal. A catheter was obstructed at 10 centimeters from the bladder, on the left side. The urine contained pus cells, many epithelial cells, and cultures showed B. proteus. The function on this side was markedly diminished. X-ray films (Fig. 1) showed a massive calculus impacted in the left ureter.

Owing to the poor cardiac function, he was placed under medical treatment for six months, at the end of which time his cardiac condition seemed to have reached its maximum of improvement. Blood chemistry was normal, and phthalein output normal.

Operation was performed November 2, 1929. Through an oblique lumbar incision, the left kidney was explored, found to be atrophied, and surrounded by a thickened, densely adherent, fatty capsule. The incision was prolonged downward and forward, exposing the ureter, retroperitoneally, to the bladder. The ureter was enlarged to the size of the small intestine, was adherent to the peritoneum, and surrounded by a thick layer of fat and lymph. An enormous

*Read by title.

calculus could be palpated extending from the pelvic brim to the bladder. The ureter was opened at the pelvic brim and with considerable difficulty—owing to the tight impaction of the calculus in the ureter, and the calculus was extracted (Fig. 2). There were two definite well-formed joints in the stone, with smooth articular sur-

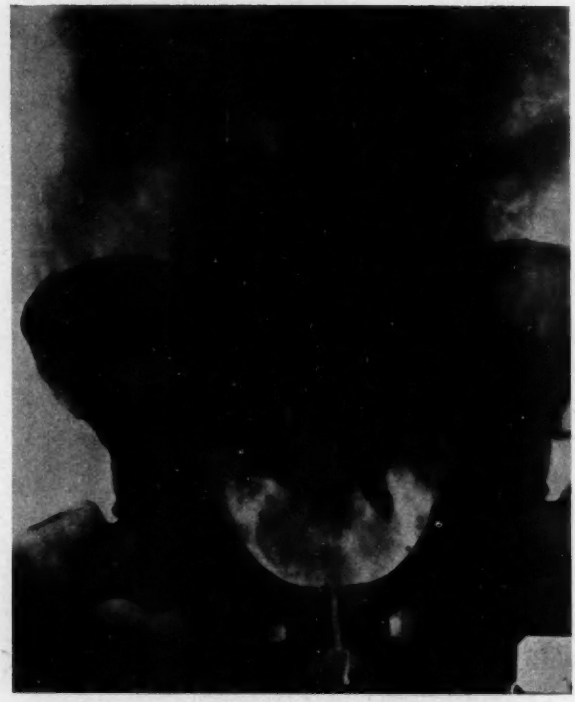

Fig. 1. Calculus impacted in left ureter.

faces (Fig. 3). These joints apparently allowed the calculus to move with body motions, and were largely responsible for the absence of pain. The gradual growth in the size of the calculus had taken place without a complete obstruction to the outflow of urine, which allowed the kidney to atrophy slowly without sudden ob-

struction, which would have caused a colic; and the mobility of the calculus with its joints prevented hematuria.

The postoperative course was satisfactory, as far as the urinary

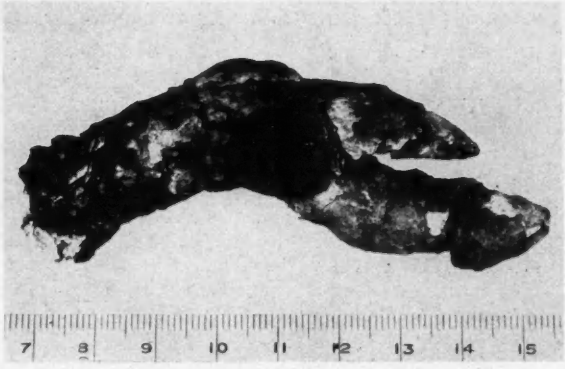

Fig. 2. Calculus after removal.

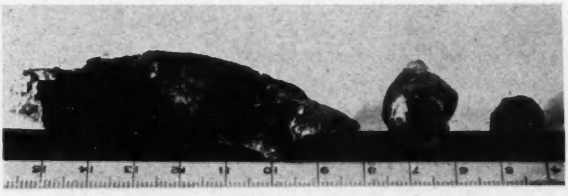

Fig. 3. Sections of calculus showing articular surfaces.

tract was concerned. Drainage of the ureter ceased promptly; a catheter which was used for ureteral drainage was removed four days after operation, and the wound was closed in seventeen days.

During the convalescence, the patient had three emboli in the

lungs, and one in each leg, from all of which he made a satisfactory recovery. The cardiac condition was serious for some time, but compensation became established, and when last seen, January 20, 1930, he had no edema; urinary function was normal, the urine acid, and contained only isolated pus cells.

This case is interesting because of the absence of symptoms caused by the presence of the calculus, the large size of the calculus and its perfect joints allowing free mobility.

VESICOVAGINAL AND RECTOVESICAL FISTULÆ

WITH REPORT OF A CASE OF CONGENITAL RECTOVESICAL FISTULA

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Among the different types of vesical fistula which may occur, vesicovaginal fistula is perhaps the most deplorable in its subjective effects, because of the constant dribbling of urine, although rectovesical fistula is scarcely less so, as, in addition to the escape of feces in the urine, there is often an involuntary discharge of gas from the urethra.

It is not my purpose in this paper to discuss in detail the treatment of either vesicovaginal or rectovesical fistula, but I do wish to emphasize the point that for each condition the choice of treatment must be highly individualized, as it will depend upon the cause of the fistula, the location of the openings, their size, and the condition of the fistulous tract between them. I wish also to call especial attention to the need for the urologist to appreciate the importance of these conditions. We are too apt to consider that the treatment of vesicovaginal fistula pertains only to the field of the gynecologist and that of rectovesical fistula to that of the proctologist, although a urinary organ is involved in each case, and urinary complications are almost sure to follow the presence of fecal matter in the bladder in the one case, or infection may enter the bladder by the vaginal route in the other.

INCIDENCE

I can find no direct reference to the incidence of either vesicovaginal or rectovesical fistulæ except that they are rare. I myself have observed thirty-two cases.

In 1867 Sims analyzed 275 cases of obstetrical injuries of the vesicovaginal septum. During the period from 1856 to 1861 he performed an average of two operations a week for such injuries. Bissell[1] reports that during the ten years previous to

1929 only fifty-eight patients were operated upon in the Woman's Hospital of New York for the repair of vesicovaginal or urethrovaginal injuries. This apparent diminution in the incidence of vesicovaginal fistula due to childbirth is doubtless the result of improved obstetrical methods.

As for enterovesical fistula, of which I have observed twelve cases, in 1915 Cunningham[4] collected 336 cases to which he added six of his own. It is interesting to note that he does not mention the possible congenital origin of this condition. Sutton[7] reports that from January 1, 1907, to January 1, 1920, only fifty-nine vesicoenteric fistulæ were operated upon at the Mayo Clinic.

More cases of enterovesical fistula occur in males than in females, this being especially true of those cases which are of congenital origin. Among the ninety-five cases of enterovesical fistula collected by Chavannaz,[2] 70 per cent were in males. In congenital cases in the female, the opening from the bowel is usually into the vagina, while in the male the opening is between the bowel and the base of the bladder or the prostatic portion of the urethra. My own congenital case was in a female, the opening being between the bowel near the sigmoidorectal junction and the bladder.

Cripps[3] in 1884 reported twenty-five cases of congenital rectovaginal and rectovesical fistula. The only case of congenital rectovesical fistula that I have been able to find in the literature since that date is one reported in 1927 by Echemendéa. Cripps adds no more cases in the fourth edition of his book published in 1913. Of the cases reported by Cripps, thirteen were in males and twelve in females. In all the female cases the opening was into the vagina. In six of the male cases a fistulous communication was found between the prostate and the rectum. In one of the others the rectum terminated at the fundus of the bladder, in another the communication was by a minute opening at the base of the bladder, in still another it terminated close to the urethral opening, and in the fourth case the bowel ended at the sigmoid flexure which communicated with the upper part of the bladder. Cripps does not mention the site of the fistulous opening in the other three cases, the only patients of the thirteen male cases to survive. Whether or not Cripps includes in his series the case reported by Minich[6] in 1880 I do not know. This

case is of interest only because of the naïveté of the author in citing prenatal influence as a possible cause. "When the mother was about four months advanced in pregnancy the father had an attack of flatulent colic and was given several rectal injections under suprevision of his wife, who was nervous and frightened."

ETIOLOGY

A vesicovaginal fistula may be due to direct surgical injury, to an interference with the blood supply by suture, or by pressure of the fetal head, or a pessary, to injury by forceps in the course of a delivery, to syphilis or cancer. According to Kelly,[5] injury by forceps is rare, the trouble arising, "not because forceps are used, but rather because they have not been used soon enough, or because of the failure to do a symphyseotomy or a cesarean section in a labor almost impossible by the natural ways."

Enterovesical fistula may be traumatic, ulcerative, cancerous, tubercular or congenital in origin. Sutton groups the etiologic factors of vesicosigmoidal fistula as follows:

A. Traumatic
   1. Accidental
   2. Intentional

B. Non-traumatic
   1. Inflammatory
      a. Abscess
      b. Stricture
      c. Stone
      d. Ulcer
      e. Diverticulitis
   2. Tumors
   3. Congenital anomalies

Although Sutton thus mentions the possibility of a congenital origin of enterovesical fistula, he neither reports such a case nor cites any from the literature. In my own series of twelve cases the probable causes were diverticulitis, stone, abscess, operative trauma, carcinoma, and congenital anomaly. In one case now under my care the fistula was between the appendix and the bladder, and was apparently caused by the passage of a pin through the wall of the appendix to the bladder, where it had become the nucleus of a stone.

DIAGNOSIS

The diagnosis of vesicovaginal fistula presents but little difficulty, the principal symptom being incontinence of urine, although it should be borne in mind that in the case of a small fistula situated high in the vagina the urine may be voided normally. In any case of incontinence of urine, therefore, especially in a woman who has borne children, or who has been subjected to a pelvic operation, the vagina should be carefully examined to discover whether or not a fistula is present. In case of doubt, dye may be injected into the bladder, its presence in the vagina indicating both the presence of a fistula and its site.

The site of the vaginal fistula may be determined also by digital examination and by the use of the speculum, while the site of the opening into the bladder may be identified by cystoscopic examination and the passage of a probe.

The presence of a vesicorectal or vesicoenteric fistula is indicated by the passage of gas from the urethra, by the presence of feces in the urine and by the more or less constant escape of urine from the rectum. A urethrorectal may be differentiated from a vesicorectal fistula by placing the patient in dorsal decubitus and injecting dye into the bladder, this being followed by a proctoscopic examination. If the opening is in the urethra the dye will not appear in the rectum until the patient urinates. Digital examination and the use of the proctoscope will usually determine the site of the opening in the rectum, and cystoscopic examination the site of the opening in the bladder. Cunningham calls attention to the fact that the location of the opening in the bladder is usually more easily determined than that in the rectum, although by the injection of dye into the bladder the latter can usually be identified.

TREATMENT

As mentioned above, the treatment of either vesicovaginal or rectovaginal fistula is strictly individualized. In the case of a vesicovaginal fistula, if the opening is small, it is safe to wait to see if it will close without a plastic procedure, although in general early operation is imperative if primary healing is to be secured, as otherwise, repeated operations may be required. In the twenty-seven of my own cases which were treated surgi-

cally, forty-four operations were required before the fistula finally closed. In cases in which a local plastic operation can not avail, a transplantation of the ureters to the rectum should be done.

As for rectovaginal fistula, the operative procedure depends upon the cause of the opening. Entirely different procedures are required, for example, in the presence of a malignant condition from those indicated if the cause is traumatic, or in the presence of a non-malignant condition such as stricture, diverticulitis or an ulcer. It should be borne in mind that a fistulous tract may be present between the two openings. Kelly states that in about 25 per cent of the reported cases of enterovesical fistula there was an intermediate suppurating cavity between the vesical and the intestinal orifices.

CASE REPORT

In my own case of congenital rectovesical fistula, the child, a girl, was born with an imperforate anus because of which a colostomy was performed a few hours after birth. It was noted later that the urine contained fecal matter. Therefore, as soon as the colostomy was functioning the abdomen was opened and a fistula was found near the rectosigmoid junction connecting the large bowel with the bladder. The fistulous tract was divided, the edges of the two openings were inverted and the openings closed. The abdomen was closed without damage. Later, an artificial anus was formed, the gut being brought down well through the incision. The colostomy was closed later and the redundant gut removed.

The child, who is now seven years of age, has been entirely free from bladder infection and has a good anal function except when she has watery stools, when there is some incontinence.

The child has no vagina, and apparently there is not sufficient septum with which to make an artificial one. My intention is to wait until the sexual characteristics develop and then sterilize her, perhaps with the X-ray.

REFERENCES

1. Bissell, D.: Vesicovaginal fistula: An appreciation of Marion Sims and his work. Am. Jour. Surg., n.s., 7:143-156, 1929.
2. Chavannaz, G.: Des fistules vésico-intestinales acquises chez l'homme. Ann. d. Maladies d. Organes génito urinaires, Paris, 15:1176-1199, 1287-1321, 1897; 16:203-220, 1898.
3. Cripps, H.: On Diseases of the Rectum and Anus. P. Blakiston, Son & Co., Phila., 1884, p. 25.

4. CUNNINGHAM, J. H., JR.: Rectovesical and entrovesical fistulæ. Surg., Gynec. and Obst., 21:510-518, 1915.
5. KELLY, H. A., and BURNAM, C. F.: Diseases of the Kidneys, Ureters and Bladder. D. Appleton & Co., New York, 1914, Vol. ii, p. 410.
6. MINICH, A. K.: Rectovesical fistula with occlusion of anus. Med. Bull. Phila., 2:14-15, 1880.
7. SUTTON, G. D.: Vesicosigmoidal fistulæ. Surg., Gynec. and Obst, 32: 318-327, 1921.

THE ORIGIN OF CONGENITAL DIVERTICULA

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Two years ago, before the American Urological Association, Caulk[1] presented a case report that suggested the "possible origin of certain diverticula of the bladder." His observation was the clinical study of a three months old infant (girl) in whom cystoscopy revealed a reduplication of the left ureteral orifice. While observing this orifice, peristalsis was seen to occur and the upper ureteral opening gaped like a diverticular orifice, slowly drew the lower orifice into its cavity, then as peristaltic function receded, the normal was again gradually restored to the typical appearance of a simple reduplicated ureteral orifice.

Since this report I have studied two similar cases: the first a clinical observation in an adult, the second an autopsy in a child. The close bearing that these cases present to diverticular formation makes them worthy of report.

There is little to record in regard to the embryology of reduplication of the ureters, for we recognize two possible origins for the occurrence of such: (a) a splitting of the ureteral bud as it first develops from the wall of the Wolffian duct or mesonephros, and (b) the development of two separate anlagen. In the condition with which we are dealing, one bud proceeds to normal development, the other remains rudimentary. The one outstanding and most interesting factor observed in both Caulk's case and in my clinical observation (about to be reported) was that this rudimentary orifice and partially developed ureteral bud underwent rhythmic peristalsis—opening, drawing upward, gaping wide open (at which moment the lower orifice is drawn towards or into the false one) and then gradually resuming the quiescent state. It is at the height of this act that the false orifice exactly simulates that of a diverticulum.

Case 1.—J. H., male, aged thirty-seven years, consulted me on January 29, 1930, bringing with him a splendid X-ray film showing

a typical staghorn calculus in the right kidney pelvis. There was nothing in his history, habits, or occupation of any value as bearing upon the causation of this stone. Cystoscopy showed a normal bladder cavity and wall, a normal left ureteral orifice, but at the right trigonal cornu were found two ureteral openings: the lower one was small, rather punctate and quite round; the upper one

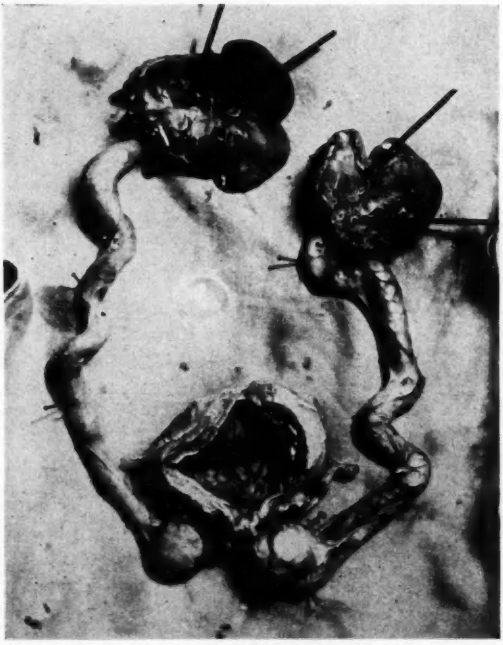

Fig. 1. Kidney damage, bifid renal pelves, dilated ureters, bilateral diverticula, and concentric hypertrophy of bladder muscle.

was larger with slightly redundant edges and characteristically crescentic in outline. Both orifices could be observed in the same cystoscopic field. When watched, the upper one was regularly the first one to show peristaltic motion, which was quite slow, and while going through its cycle, the lower orifice would start to function and complete its act at about the moment of the greatest gaping of the false orifice and at the time of its greatest similarity to a

diverticulum. At this moment the true ureteral orifice was drawn to the very edge, or lip, of the false opening.

This patient entered the hospital, had repeated cystoscopic studies, pyelograms both cystoscopic and intravenous, with X-ray plates of a catheter in the true ureter and one curled in the false, whose lumen accepted 5 cm. of the catheter before the tip would reappear at the point of entrance. No function from the false orifice was detected on the plates after intravenous pyelography.

Fig. 2. Bladder and diverticula laid open to show relation of diverticula to the true ureteral orifices.

At operation, the right kidney with its branched calculus and portion of the ureter was removed, and gave no evidence of abnormal embryological development.

Case 2.—This specimen was most kindly given to my museum by Dr. Thomas Cope, pathologist to the Germantown Hospital. The condition was found at autopsy upon a six year old, undeveloped child, whose life terminated in a state of uremic coma. The kidneys, ureters, and bladder were removed in one mass and carefully dissected free of superfluous tissue. Two rather hydronephrotic and misshaped kidneys were found, each with bifurcated pelves; the ureters were bilaterally equally dilated and markedly tortuous, though single, and measured on an average 15 mm. in diameter. The bladder was found as a strongly musculatured and trabeculated

viscus. At the ureteral termination, just proximal to the bladder, each ureter apparently swelled out into a bulbous mass, two or more times larger than the portion above. When the bladder was opened what appeared to be symmetrically placed diverticula orifices were seen at each trigonal cornu, whose cavities created the bulbous swelling about the terminal ureter. A ureteral orifice was found just on the lip of the diverticulum on the right hand side but on the left the true ureteral orifice was found only when the diverticulum was laid open showing the ureteral meatus a full centimeter within the diverticular cavity. It appears from the specimen that the upper bud formed the diverticulum in each instance—on the right it is quite definite that the upper was the rudimentary or diverticular bud, as seen in both Caulk's and my clinical case; while on the left the distortion is greater, for the diverticulum has grown and pushed lateralward and the ureter emerges on the mesial wall of its cavity. It is without question that the obstruction produced by this abnormal development was the cause of the upper urinary tract lesions which in turn caused the child's death.

CONCLUSIONS

1. From these three observations, two clinical and one postmortem, varying as they do in their degrees of development, it appears sufficiently clear and safe to conclude that rudimentary ureteral budding may be the cause of congenital diverticula.

2. The observation of regular periodic peristaltic action in both Caulk's and my clinical observation is of particular interest as it affords assurance of the ureteral origin of such diverticula and allows of both embryologic and pathologic understanding of the postmortem case.

3. It is suggested that, in studying cystoscopically diverticula placed near the ureteral orifice, time be employed to watch for sluggish peristaltic action so that further data on their possible origin may be observed and recorded.

REFERENCE

1. CAULK, J. R.: The ureter as a possible origin of certain diverticula of the bladder. Jour. of Urol., Jan., 1930, XXI, p. 23.

INTRA-URETERAL LITHOLAPAXY

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There has been an increasing tendency for urologists to utilize various intra-ureteral, cystoscopic, manipulative technics for the removal of ureteral calculi.

At the present time the majority of stones in the ureter either pass spontaneously or can be removed by cystoscopic means.

My personal experience has been that less than 7 per cent of 330 cases of stones in the ureter have required surgery. With delicate and aseptic technical care and patience many stones can be removed without operation which were formerly treated by surgery.

The innumerable technics that have been proposed for stone removal need no rehearsal. Gentle dilatations below the stone and efforts at increasing ureteral peristalsis are necessary in any of these procedures. I have always been of the opinion that forceful dilatations and special instruments for grasping stones in the ureter have had very few indications.

I am reporting the history of a patient who presented a stone in a dilated ureter of an only kidney and whose general condition at the time was far from good. Owing to the size of the ureter and the character of the stone shadow, particularly its movability, I designed to crush the stone in the ureter and evacuate the fragments. This, as far as I can determine, is the first time such a procedure has ever been attempted in a rather large stone in the ureter.

The patient, a young man, aged twenty-one years, came to me complaining of pain in his left side and back. He had consulted a urologist in the East two weeks previously. At this time he had hematuria which had been brought on, according to his story, by overexertion from golf. There had never been any previous bleeding. He was investigated and shadows were found in the lower calix of the left kidney. Pyelo-ureterogram at that time showed an enormous dilatation of the lower ureter.

When he consulted me he was still suffering with recurrent at-

tacks of left renal pain which were not severe and which did not radiate. He was having absolutely no bladder trouble, no fever or chills and no loss of weight.

Examination revealed that neither kidney was enlarged; there was no tenderness in the kidney region. Voided urine was hazy in

Fig. 1. Ureterogram showing considerable dilatation of lower ureter.

both glasses. It showed a trace of albumin, a moderate number of pus cells, an occasional red cell and staphylococci.

The cystoscope passed easily. Bladder was normal, catheters passed easily into both ureters, the left blocked within the ureteral opening, then passed. There was enormous retention withdrawn from the left ureter, none from the right. Urine from the left showed infection, the right was negative.

Phthalein given intravenously appeared in three minutes on the

right, in eleven minutes on the left and very pale. From the right there was 10 per cent in six minutes, and a bare trace from the left in a corresponding length of time.

X-ray taken with catheter in place showed a shadow in the lower

Fig. 2. Four months later, stone in lower calix of right kidney, dilatation of lower ureter.

calix of the left kidney; the right was negative for stone. Pyelogram of the left kidney showed hydronephrosis and hydro-ureter. A later ureterogram showed an enormous dilatation on the left ureter (Fig. 1). The right ureter was slightly dilated in the lower part but there were no shadows anywhere along its course.

Owing to the compensatory function of the right kidney it was felt that the left kidney had been pretty badly hurt by the stasis with infection.

Against my better judgment I attempted to institute freer drain-

age to the lower ureter by incising the orifice through a cystoscope. This procedure had worked excellently on many occasions in my hands but in this instance it proved somewhat disturbing in the later course of events. In the first place, it allowed regurgitation of the bladder contents up the ureter through the wound after nephrectomy; this, fortunately, was of short duration. It also, through later scarring and contracture, prevented efficient emptying of the ureteral stump, the consequent pyo-ureter being a disturbing element in the convalescence.

Fig. 3. Stone in lower right ureter, none in kidney.

The patient returned to his work in the East and was in very good health until three months later when he was seized suddenly with a colic on the right side. This happened while he was visiting his home and he again came into my care. This time he was quite ill, colic was severe, he had chills and fever, and pronounced reac-

tion. X-ray was taken which showed a rather large stone in the lower end of the right ureter measuring about 1.5 cm. in length by 1 cm. in width. Ureterogram showed the ureter to be about the size of an index finger and rather blunt at its lower end (Fig. 2). The stone could be dislodged easily and could be made to ascend promptly to the kidney or drop to the lower ureter by changing

Fig. 4. Forceps inserted in ureter, dilated, grasping stone.

the position of the patient. Indeed, the stone would ofttimes play "hide and seek" between the lower end of the ureter and the kidney pelvis without postural change and served as a beautiful illustration of reversed peristalsis of the ureter (Fig. 3). The patient had several rather severe colics and required an indwelling ureteral catheter to tide him over one or two of these storms. Cystogram done during intervals between colics showed absolutely no regurgitation up the ureter at this time on either side.

The patient could not expel the stone after repeated dilatations, and colics became more frequent.

On account of the tendency for the stone to drop immediately to the lower more dilated ureter when the patient was in the upright position, I prepared to crush the stone and evacuate the contents.

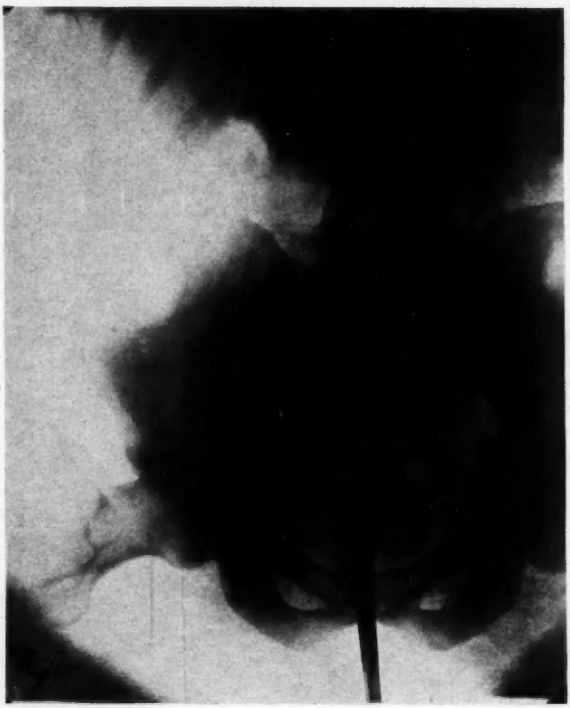

Fig. 5. Forceps in ureter, dilated, with no stone present.

Under sacral anesthesia the Lewis forceps were placed in the ureter and then opened. The patient was placed in the upright position and jarred, the forcepts then were closed gradually and it was perfectly easy to feel the stone in the jaws. X-ray proved this as shown in Fig. 4. Then by firm pressure on the handle of the instrument the stone was crushed by the heavy jaws of this very excellent instrument of Dr. Lewis. Repeated graspings of fragments were made in a manner similar to the ordinary Bigelow

lithotrite. Each time it was easy to appreciate the feel of the fragments in the jaws until finally nothing more could be grasped.

Then the instrument was withdrawn and a very large catheter inserted into the ureter for lavage of its lower part and suction made at the distal end of the catheter until considerable amount of sandy material was evacuated. Following this an X-ray was taken which showed the absence of stone in the ureter (Fig. 5). Bulgara emulsion was instilled in the ureter.

The result was indeed most striking and excellent. The patient was immediately and entirely relieved of plain, had no reaction and left the hospital in a very short time.

Several days later he passed a small fragment of stone from the bladder.

This operation was quite simple owing to the fact that the ureter was dilated and patient very coöperative. It certainly, in this instance, was far superior to the open operation, as it was just as simple as any of the standard intra-ureteral manipulations. It must be understood, however, that such a procedure is not suggested for impacted stones in the normal ureter; but in the rarer instances of dilated canals this operation has a definite indication.

DISCUSSION

Dr. William C. Quinby (Boston): Apropos Dr. Lower's communication, in which I was exceedingly interested, I think I express the experience of most of us, that as urologists we see more difficult and possibly more hopeless or more complicated cases of vesico-vaginal fistulæ than do the obstetricians or the gynecologists. It has been my fate to see a number of instances of very extensive laceration involving the floor of the bladder and making a communication between the bladder and the vagina or between the bladder, vagina and uterus.

In the type of case of which Dr. Lower speaks, I agree that the vaginal approach is quite adequate and therefore is the most satisfactory operative approach, but in the more extensive cases this is not so. I remember, at the moment, a woman in whom the tear was so extensive that on vaginal examination the fingers immediately entered the vault of the bladder. In tears of this extent, especially when the uterus is also involved, I am of the opinion that a suprapubic approach is best, and that some of the most extensive lesions will not be repaired until a hysterectomy is done, before carrying out the suture of the floor of the bladder. A panhysterectomy may be needed, because some of these lacerations involve the whole anterior wall of the cervix, extending sometimes above the internal os. I feel sure that only by a very wide approach, either with or without hysterectomy, will these more difficult cases be cured.

Dr. David W. MacKenzie (Montreal, Canada): A few years ago, I think it was at a meeting in Richmond, Virginia, we took up a series of cases that we had on the service at that time. As you perhaps remember, we had only one patient who had not been operated on before, a young woman who was open entirely from the cervix to the urethra but easily closed. Of the others, one had been operated upon twenty-two times, one of them seventeen times, and the lowest seven times.

Since that time the condition remains about the same. We have had only two patients who have not been operated on before coming to us.

Our difficulties were with the extensive destructive condition

with much scar tissue, the absolute lack of tissue to work with, and we found that the extensive dissection was of first importance. The next was to pack the vagina to form a watershed for the suture line in the bladder.

The next difficulty we have had (and that applies to the first case we showed in Richmond) is the loss of a sphincter, and too often, I think, we try those cases without settling definitely in our minds how much sphincter we have to work upon. Of two of our cases, both of them obstetrical cases with contracted pelves that had been very extensively riddled, the first patient had had seventeen operations and the other had had eight, with no sphincter muscle left. In both cases we had to transplant the ureters into the bowel.

In the cases to which Dr. Quinby referred, where there is an opening from the bladder into the cervix, it is generally the upper part of the cervix. We have operated from below and found these easier.

Reviewing, I think our difficulties have been, first, the lack of sphincter, and, second, the extensive scar.

Dr. Hugh H. Young (Baltimore): I have had so little experience with vesico-vaginal fistula in comparison with the great number of cases which Dr. Lower has treated that I hesitate to express myself on this splendid paper which he has given us.

I wish to stress here the great value of the suprapubic route of approach. Certainly in those cases in which attempts have been made to close the fistula through the vagina, operation through the bladder should, in my opinion, next be tried. One of the difficulties in the past has been that the fistula lay very deep in the base of the bladder and resection of the edges was unsatisfactory, and their approximation inaccurate.

Several years ago I presented different types of instrument by which traction could be made, so as to draw the fistulous opening well up to the operator and facilitate thorough and accurate resection of the scar tissue. For such a purpose one may employ a safety pin straightened out and bent into the form of a small hook. This, passing through the fistula into the vagina, makes an excellent instrument with which to carry out resection of the fistula. I have also used a minute double bladed tractor similar to my prostatic instrument, which works very well, and

is particularly helpful in placing the sutures. Where the fistula is fairly large, my long urethral seminal vesicle tractor or the ordinary prostatic tractor may be employed. One particular reason for going through the bladder is the frequency with which the trigone or ureteral ridge or orifice is involved in the fistula. In one of my cases the ureteral ridge had been torn free from the bladder, and formed a bridge across the orifice of the fistula, and another ureteral orifice lay in one edge of the fistula. It is only by suprapubic exposure that such conditions can be adequately dealt with, and one can be sure that he is not including the ureteral orifice in the closure. Operating through the bladder one can get three or four lines of suture. In addition to this, where tension is required to bring the edges together, one may add reinforcement by placing silver wire sutures and tying them in the vagina. These sutures can easily be placed through a suprapubic wound before the catgut sutures are placed, and then tied, after approximation of the wound with catgut is completed, by having an assistant simply twist the ends in the vagina. In this way tension sutures of silver wire, which is a particularly good material to use on account of its antiseptic qualities, can be successfully employed. One of the most important factors of the suprapubic approach is that excellent dependent drainage with the patient on the abdomen may be obtained. This plan, which was recommended several years ago by Chute, has been successful in my practice. In those cases which are associated with injury of the external sphincter, and where a repair is necessary to relieve incontinence of urine, the extravesical operation certainly gives a better chance of restoration of the internal sphincter.

Dr. Charles M. McKenna (Chicago): I think Dr. Lower's operation is excellent and I congratulate him on the technic of his operation. I believe every vesico-vaginal fistula, however, is an individual one and the technic will vary according to where the fistula is.

I think the point of greatest importance in the management of technic is keeping the urine away from the sutures. If the fistula be in the center of the vaginal wall, that makes the operation more simple. In that way the resection can be made as described by Dr. Lower, and then packs can be put in the vagina

to raise the center of the bladder wall up so as to throw the urine into the two sides in the way described by Harris, some years ago. Then two catheters can be placed in the bladder and the urine drained off without interfering with the wound.

Dr. Young pointed out a very interesting procedure to me, when one is dealing with a fistula which involves the ureter. We have had a number of those cases and finally got the best results by making the resection as we would when the wound is further away from the ureter, by introducing a catheter into the ureter and bringing it out through the urethra, or, if we felt that we could not get drainage that way, we would bring it out through the vagina through the newly made incision. We believe that if the bladder mucosa is invaginated in the ureter and the catheter brought through the vagina through the wound, that healing will take place.

We also have had some of the cases described by Dr. Quinby where the laceration in the vagina is very exaggerated. In these cases we got the resection through the vagina first and then made a suprapubic opening and brought the posterior wall of the bladder anteriorly and sutured it up well into the suprapubic space, thereby throwing the urine into two separate canals. The bladder was allowed to remain in that position until healing took place; at that time it was relaxed, put back into position and the bladder allowed to close as in any other suprapubic opening.

Dr. Harry A. Fowler (Washington): I just want to speak of an experience we had some years ago which represents my only excursion in the field of gynecology. This patient came to us from New York State with a history of three years of incontinence. The urine was escaping from the vagina continuously, and the fistulous opening had been made purposely to relieve an intolerable vesical spasm due to some intravesical lesion. The diagnosis of new growth had been made, and this method was sought to give relief.

When the patient came under our observation she had total incontinence, but the cystoscopy showed a bladder mucosa apparently normal. Further investigation showed a destroyed right kidney, due to an old tuberculosis of the kidney.

Our first procedure, then, was to remove the kidney and get rid of the source of infection higher up. There had been prac-

tically an autonephrectomy, with a clearing up of the condition in the bladder.

After the operation we sent the patient out until she was in better condition. We then readmitted her to the hospital and attacked the fistula. We did it in a simple way, showing that some of these cases are not nearly so severe as the cases with a different etiology.

We performed our operation under local anesthesia, making a longitudinal incision around the fistulous opening, that is, taking in the fistulous opening, dissecting this up, with a flap of the vaginal mucosa on either side. We then went down and exposed, by dissection, the bladder wall, mobilizing it for a considerable distance around our incision, enabling us to bring it together very nicely and without tension in the opposite plane, in the horizontal position. The wall of the bladder was then brought together, the wall of the vagina in a second layer of sutures, and finally the mucous membrane of the vagina.

We put in just an ordinary Pezzer catheter for drainage, and the patient healed promptly. Despite the fact that there was a history of tuberculosis behind this condition, the opening has remained closed, because the patient comes in to see me every year when she comes to Washington. This has been, I think, six or eight years since the operation, and she is still functioning all right.

DR. BRANSFORD LEWIS (St. Louis): I want to say that my friend John Caulk went way beyond my most ambitious dreams with respect to this instrument. In developing it, I had certain ideas in view: to give the forceps a little longer reach, so that when it was opened in the ureter it would grasp and hold the stone, assisted by the concavity in the jaws and the serrations provided. Thus if the stone is grasped it may be dragged out.

Of course, there has always been the preliminary fundamental requirement that the ureter must be dilated before it is attacked in that way. The form of biting forceps that has been in vogue is so short that if one ran against a stone with it open, and closed it, it would expel the stone from the jaws. The idea of this instrument was to provide a longer reach.

Dr. Caulk went beyond that in his crushing. He has demonstrated very beautifully the X-ray findings, which, I think, is a

good thing. By taking incidental negatives one can see just where he is.

DR. WILLIAM E. LOWER (Cleveland): I appreciate very much the interest that has been taken in this deplorable condition, vesico-vaginal fistula.

One of the points that I wanted to bring out was, if you can, convince the obstetrician that many of these cases would be repaired primarily if they were repaired soon after they occur, instead of waiting until urinary concretions have formed in the wound, or the tissues have become fixed from scar tissue, just as perineal repair is now made at the time of delivery while the tissues are still fresh and pliable.

Second, no one method will work in all cases. I believe that the genito-urinary surgeon is in a position to do as much with this as the gynecologist. If the first attempt at repair is not successful it should not be tried again immediately, but the surgeon should wait until the result of the previous operation has cleared up, and then try again, and a third time or a fourth time, or as often as may be necessary.

This brings up another very important point—the question of malpractice. I have been called upon as a witness in these cases to say whether or not these patients were entitled to damages as the result of the fistula. I have always tried to defend the surgeon in these cases, for it is a condition that oftentimes cannot be avoided. It frequently occurs in pelvic operations. The patient at no time is responsible for the condition, and consequently the patient, as a rule, feels rather better. I feel that every resource that we have must be resorted to.

The technic I described is only for a certain type of cases. I have operated by the suprapubic route and have dissected the bladder quite free and have tried all sorts of things, but I have persistently kept at it as long as the patient would consent to come back. Some of these patients I have operated on as many as seven times before I succeeded in getting a good result. As I said, I have done forty-four operations on twenty-seven cases. In those cases which result from the application of radium, or from a cancer, there is little one can do. It is the accidents following pelvic operations or following delivery that can be helped.

DR. JOHN R. CAULK (St. Louis): I was very much pleased

to hear Dr. Randall's report of the two cases of diverticula of the bladder. It has been my impression for a long time that these diverticula have a definite background, and because of the fact that they were so frequently located in the region of the ureteral orifice or the urachus, it seemed to signify it.

Dr. Randall has given the details of the history of a little girl I reported. She had this definite affair. The ureter was about two and a half centimeters long. You could see this opening and closing. It assumed absolutely the appearance of a diverticulum.

I have never been able to understand how a small blister of the bladder mucous membrane could dissect out and make a creditable diverticulum, a diverticulum holding a pint or even a quart, as some of them do.

The wall of the diverticulum suggests some fundamental structure, and the orifice also presents, always, a definite sphincteric-like appearance. If a development has been ineffective in making a proper ureter, it has also been ineffective in making a proper orifice. The valve is interfered with, therefore we may not have to have obstruction at the neck of the bladder to create back pressure to dilate these ureters. With the ordinary acts of urination the pressure is sufficient to dilate the orifice gradually.

This little girl had no obstruction at all; she has no retention. I have just recently seen her, and I am about to investigate her again, two years later. I don't know what she has, but she had on both sides regurgitant ureters that were not mixed up in this diverticulum process.

SOLITARY PAPILLOMA OF THE LOWER (RIGHT) URETER SECONDARY TO RECURRENT PAPILLOMATA OF THE BLADDER

H. A. FOWLER, M.D.

Washington, D. C.

We have had occasion recently to review the literature of tumors of the ureter in connection with a case of solitary papilloma of the lower right ureter found at autopsy. This occurred in a patient whom we had observed for a period of eleven years, during which time he had several recurrences of papilloma of the bladder. The case presents certain features which are unusual, at least we have not found an exactly similar case report in the literature.

During the past few years an increasing interest has been manifested in the study of the ureter. This is clearly shown in the rapidly increasing number of contributions dealing with its physiology and pathology. Lesions of this organ, heretofore neglected, have taken on a new interest and a new clinical significance.

Tumors of the ureter are relatively rare. But the increasing number of cases reported in the literature of the past few years indicates the widespread interest in the subject. Since the condition is relatively uncommon, the number of cases reported from any one clinic is naturally limited. It is only by collecting and analyzing the scattered case reports, as has been done in several recent contributions, that we have presented to us a very satisfactory and comprehensive clinical study. In a review (1924) of 248 collected cases of tumor of the kidney pelvis and ureter to which five personal cases are added, Thomas of this Association gives the following analysis of the distribution of the tumor in this series: kidney pelvis alone, 33 per cent; kidney pelvis and ureter, 14 per cent; kidney pelvis, ureter and bladder, 7.7 per cent; kidney pelvis and bladder, 1.2 per cent; ureter and bladder, 0.4 per cent. It is thus apparent that the association of tumor of the bladder and the ureter is very rare. No statistics are

available as to the relative frequency of occurrence of tumors of the ureter alone. It is perfectly clear, however, from experience and a survey of the literature, that, while bladder tumors are relatively common, tumors of the kidney pelvis are very uncommon, and rarest of all are new growths of the ureter.

Tumors of the ureter may be conveniently classified according to their histological structure into:

1. Sarcomata
2. Mixed tumors
3. Papilloma
4. Papillary carcinoma
5. Non-papillary carcinoma
   a. Squamous celled
   b. Medullary or solid

Sarcomata are very rare. Stewart was able to find only five cases in his review of the literature.

Mixed tumors are also exceedingly rare. Recent cases have been reported by Binder and by Djeah Yän (Wätjen). In the former a tumor of the lower third of the right ureter was found at autopsy in a patient dying of apoplexy. Microscopically it was composed of smooth muscle, epithelium, connective tissue and bone. The growth evidently had been present for a long time, as evidenced by the severe grade of hydronephrosis on the affected side and hypertrophy of the other kidney. In the latter case, also obtained at autopsy, and classified as a fibromyoma, the growth was situated in the lower third of the left ureter. It apparently sprang from the outer circular muscle layer, gradually compressing and finally occluding the lumen of the ureter. It was composed chiefly of smooth muscle and connective tissue elements and in some areas showed calcification and even bone formation.

The interesting case reported by Quinby and classified as mesothelioma falls into a slightly different category and is the only case of its kind so far recorded.

Ureteral tumors may be further classified into primary and secondary, benign or malignant, pedunculated or sessile, and, as already noted, secondary tumors are by far the most common. They arise chiefly from extension into the ureter of papillary growths of the renal pelvis, although a few cases are reported

of primary carcinoma of the prostate, vesicles, or bladder, with metastasis to the ureter.

Zinner, in 1925, reports a most unusual and interesting case in which metastasis in both ureters was found at autopsy following a total hysterectomy two and one-half years before for carcinoma of the uterus.

In the discussion of this case, Bauer stated that he had found at the autopsy table ureter metastasis not so rare in contradistinction to primary tumors. He stated further that while carcinomas of the uterus for the most part metastasize to the connective tissue surrounding the ureter, giving rise to compression stenosis and hydronephrosis, one sees somewhat more commonly—and this applies to carcinoma of other organs—metastasis to the mucous membrane, causing hematuria.

It is the marked tendency of papillary growths of the renal pelvis to spread by way of the ureter to the bladder that distinguishes them from the solid tumors of the renal parenchyma. Thus the primary growths occurring at a higher level "metastasize" downward along the ureter with the stream and not against it. In many cases the upper or lower ends of the ureter only are involved while the remainder of its lumen is spared, thus recalling the involvement in certain cases of renal tuberculosis. In others, extension appears to take place by continuity, the growth creeping along the ureteral mucosa until the whole surface is involved and the lumen is completely filled by the growth.

In his valuable paper published in 1922 Aschner collected forty-seven cases of primary epithelial tumors of the ureter, of which twenty-one were papillomata, twelve papillary carcinomata. The latter group is subdivided into squamous cell, four, and carcinoma solidum seu medullare, ten. To this number should be added his own case of squamous celled carcinoma. This series shows about an equal number of benign (twenty-one) and malignant (twenty-seven) growths. During the past seven years many more cases of primary epithelial tumors of the ureter have been reported. Excellent reviews of primary carcinomata of the ureter have been contributed by Meeker and McCarthy, Kretschmer, and, more recently, Rousselot and Lamon, and McCown.

Rousselot and Lamon collected forty-nine cases of primary

carcinoma of the ureter to which they added a personal case, making fifty in all. In checking over this series, we find one duplicate, Hoffman's case, reported by Finsterer. Poll's case should not be included, since there was associated a tumor of the renal pelvis. And the case reported by Rayer, included here, is classified by Aschner as a papilloma. Deleting these three cases and adding the following, not included, Thompson Walker, Player, Volante, Key (two cases), and also adding the case of McCown published subsequently, we have fifty-three cases of primary carcinoma of the ureter recorded to date.

It should be noted that Walker's case was reported as a benign papilloma before the Section of Urology of the Royal Society of Medicine. At a subsequent meeting of the Section, page 42, same reference, the author states that this patient subsequently developed signs of malignancy and died five months after operation. Multiple masses were found in the abdomen and sections of a liver growth showed carcinomatous deposits.

During the same period eleven additional cases of benign papilloma of the ureter have been reported: Bastos, Kraft, Huc, Löffler, Fjodoroff, Kleinschmidt, Gottlieb, Viethen, Cassuto, each one case, and Dosza, two cases.

A third case reported by Dosza is included here, although strictly it belongs to the group of tumor of the ureter associated with tumor of the bladder.

Two cases reported by Walker should be added, making thirteen additional cases or a total of thirty-four cases of primary papilloma of the ureter.

The history of our case follows:

Wm. McL., aged forty-two years, contractor, consulted us September 17, 1918, complaining of passing bloody urine.

Family history was unimportant except that one sister died of pulmonary tuberculosis and another at the age of seventeen years from what was said to be a "growth in the stomach."

He had the usual diseases of childhood and also pneumonia as a child. He had had no acute illness during adult life. He denied venereal disease. He was married and had two children living and well.

For twenty-five years he had had blood in the urine at intervals. At first this occurred once or twice a year, lasting from two days to a week. These attacks had been gradually increasing in frequency, especially during the year previous.

The present attack began one month before he consulted us. The urine had been continuously very bloody. There had been no associated urinary disturbance. He was beginning to feel weak and felt that something must be done to stop the bleeding.

The patient was a very thin wiry man, somewhat anemic and looked older than his age. General physical examination showed nothing of note. The urine was very bloody, containing only fresh red blood cells. There was no pus and no infection.

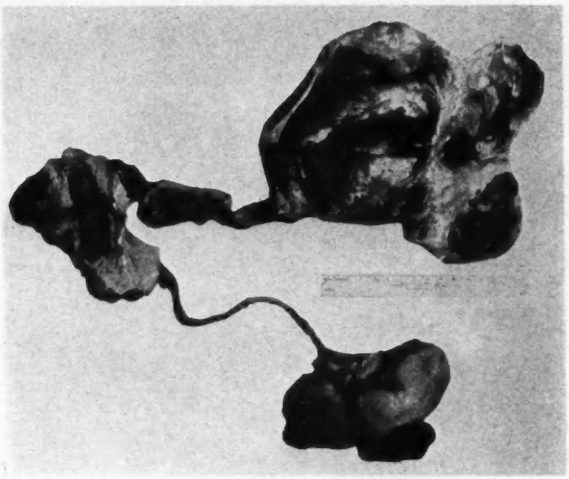

Fig. 1. Photograph of autopsy specimen. Small contracted bladder with papilloma at left base. Normal left ureter and kidney. Right kidney represented by an enormous thin-walled sac with a capacity of two liters. Marked dilatation of right ureter. At lower end of dilatation is a typical papilloma approximately size of vesical growth. Being slightly out of focus, its characteristic structure is not well shown. Lumen of ureter below the papilloma to the bladder 2.5 cm. completely obliterated.

Cystoscopy revealed a large papillomatous growth on the right side of the bladder close to the vesical outlet. Numerous villi were seen attached to the sphincter margin well within the orifice, extending up into the bladder.

An open operation was advised on account of the size and location of the growth.

At operation (1918) a large growth was found attached by a narrow pedicle to the right side of the bladder base. Numerous

small papillomata were clustered about the urethral orifice. The large tumor was removed by clamp and cautery, the base being thoroughly cauterized. The smaller tumors were thoroughly cauterized. It was necessary to plunge the cautery well within the sphincter to reach the villi springing from the urethral mucosa. There was no evidence of infiltration of the bladder wall.

Fig. 2. Marked dilatation of the right ureter just above the ureteral papilloma. The ureter below this point is transformed into a fibrous cord. The vesicle and ureteral growths show the same histological structure, Grade I malignancy.

Cystoscopy one month subsequent to discharge from the hospital showed a smooth bladder wall with no trace of tumor at that time.

The patient was next seen May 11, 1921, two years and eight months after operation. His only symptom was a slight frequency. Voided urine was cloudy, containing a few pus cells, few red cells and myriads of bacilli.

Cystoscopy showed four small papillomata the size of a pea far

back on the anterior wall near the vertex, and another similar growth on the left lateral wall. Fulguration was advised.

The patient did not return for fulguration and was not seen again until eleven months later, April, 1922. During this time he had had only two hemorrhages. He also stated that since his last visit he had had frequent nausea and vomited easily. He had been eating very little as this produced a "lump in the stomach" which was followed by nausea and vomiting. He had become very thin and emaciated. There had been little or no urinary disturbance. He stated further that during this period he had had a great deal of pain in the right renal area. Sometimes this pain was relieved by the passage of blood clots. More often, however, the pain occurred independent of hematuria. Cystoscopy at this time showed

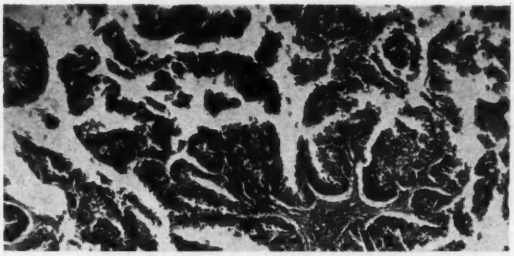

Fig. 3. Low power section ureteral tumor showing papillary structure of growth.

seven separate papillomata. These were scattered over the right side of the bladder wall. The left side appeared to be free of growth. It was definitely noted that there was no growth about the right ureteral orifice which might obstruct and explain the right renal pain. X-ray examination was negative for suspicious stone shadows. On account of his poor general condition and marked gastro-intestinal symptoms, he was referred to a gastro-enterologist for observation and treatment before treatment of the recurrent bladder growths was undertaken.

A thorough survey of the patient's condition was made by Dr. Earl Clark, April, 1922. The details of this examination need not be recorded here. The following diagnosis was made: chronic colitis, chronic spastic constipation, papilloma of the bladder, pyorrhea alveolaris. The upper abdominal pain was thought to be due to the genito-urinary condition and the colitis. There was no evidence of gall-bladder disease. A plan of treatment was outlined to correct colitis, constipation and the dental infection.

The patient did not return to us, as advised, for fulguration of

the bladder papillomata. He did go to another city on the urgent advice of a friend, where he received six or seven treatments, presumably with radium, for his bladder growths.

We next saw him January 3, 1925, at his home, where we were called to see him on account of bleeding. Hematuria had been constant for two weeks. Cystoscopy the following day revealed an extensive growth involving the anterior wall and filling the vertex of the bladder. This was thought to be malignant. Excision was advised and accepted.

On January 7, 1925, the bladder was exposed, the peritoneum opened transversely and the free edge attached by suture low down to the posterior bladder wall. The bladder was then opened widely and two large villous growths were found filling the vertex of the bladder and extending downward on the posterior wall. There was an area of uninvolved mucosa between the two growths. The whole tumor bearing area was widely resected in one piece. This included the area of normal bladder wall between the separate growths. It was estimated the bladder capacity had been diminished about one-third by the resection.

The patient left the hospital, January 27, at which time he was voiding naturally. There was frequency, about every hour during the day, and the urine was slightly cloudy due to pus and a bacillus infection. One week later the wound was entirely healed. He complained at this time of severe pain in the region of the left kidney. Palpation failed to show any local tenderness, spasm or mass. Neither kidney was felt, although the patient was very thin and the condition favorable for satisfactory abdominal palpation.

We had urged upon the patient repeatedly the importance of a periodic check-up on his bladder condition regardless of the presence or absence of symptoms. We had been thoroughly unsuccessful, however, in securing his coöperation. He did come to see us eleven months later, November 2, 1925, in response to the urgent appeals of his family. At this time a collection of small papillomata, three or four in number, was found on either lateral wall of the bladder. The surrounding mucosa was slightly reddened on the right side, but perfectly normal on the left. Immediate fulguration was advised but was deferred by the patient until April, 1926, at which time the tumors were thoroughly destroyed by fulguration under gas anesthesia.

On December 2, 1926, the patient consulted Dr. Clark again. He had been ill a month with increasing nausea and vomiting. He stated that he would get up in the morning, eat his breakfast and relish it, but before he reached his garage there would be a sudden wave of nausea and he would lose his entire meal. This nausea was accompanied at times by vertigo. Sometimes he would return to the house and eat another meal which would stay down. His appetite was poor and he had lost a good deal of weight. There

was no abdominal pain, but a sense of fullness and uneasiness in the epigastrium.

He was sent to a private nursing home for observation and treatment. A thorough survey was again made. Of particular interest was the finding of a mass in the upper right quadrant. This was slightly tender to pressure, moved slightly with respiration, and extended forward below the costal border to slightly beyond the midline. From the X-ray examination this mass did not seem to involve the stomach. The impression gained from repeated examination was that this mass was a tumor of the right kidney. The left kidney could not be felt. While under treatment the nausea was relieved, the patient gained 10 pounds in weight in two weeks and felt immeasurably better.

We next saw the patient in March, 1927, at which time he was feeling fairly well following a prolonged course of treatment by Dr. Clark. At this time we confirmed the finding of a mass in the upper right quadrant. This was smooth, rounded, and projected below the costal border. It was freely movable on bimanual palpation, and not tender. The percussion note was tympanitic over the mass. It was evidently an enlarged kidney. Examination of the abdomen was otherwise negative. There was rather marked edema of the feet and ankles. Voided urine was clear amber, acid, a heavy cloud of albumin, negative for sugar. Routine examination was advised to determine the relation of the abdominal mass to the right kidney. He never returned for this examination, however.

Four months later, I was called to see this patient. He was about to leave home for his business when he fell heavily to the floor. Examination revealed a left-sided paralysis. His speech was indistinct, but he was mentally alert. It was noted that the mass was still present in the upper right quadrant, but appeared to be somewhat smaller. An internist was called and treatment conducted by him.

We did not see the patient again until thirteen months later, August, 1929. In the meantime he had quite fully regained the use of his legs, had put on weight, was up and about and out motoring up to four weeks before I saw him. He had had one profuse hemorrhage from the bladder, December, 1928, lasting one day only. He had some frequency but no pain or other bladder discomfort. The "lump in the side" had grown very large. Previous to my visit he had been confined to bed for about one month because of increasing weakness and backache when sitting up. He had been eating well up to the last few days. Two days before, he was suddenly seized with a severe vomiting spell and vomited large quantities of a fetid brownish material. Vomiting continued the following day.

At the time of our visit, we found him cold, clammy and pulseless. He was in extremis and could probably live but a few hours. The

family readily consented to my request for a partial autopsy as soon as death occurred.

This took place one hour later. Four hours later a partial autopsy was performed by Major J. E. Ash, Medical Corps, U. S. A., stationed at the Army Medical Museum laboratory. His report gave the following information:

The body was that of a much emaciated, well developed adult white male with very little lividity; rigor had developed. There was a definite fullness in the upper right abdominal quadrant. There was a rather broad old operative scar in the midline 6 cm. long above symphysis. Superficial vessels and glands were negative as

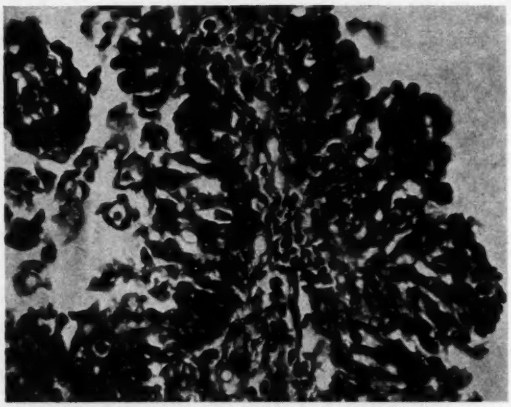

Fig. 4. High power photomicrograph showing details of cellular structure of ureteral tumor.

were external genitalia. There were no significant scars or deformities other than noted.

Examination was confined to the abdomen.

On making the primary incision a large fluctuating mass was found intimately adherent to the anterior abdominal wall. The structure ruptured on breaking these adhesions and approximately 2 liters of materials escaped having the color and consistence of chocolate syrup, not particularly offensive in odor. This mass before rupture was about 20 cm. long, about 8 cm. in greatest diameter, which was obviously the kidney.

The peritoneum was smooth and glistening. There was practically no intra-abdominal fat.

The liver was at the costal margin, was normal except that the capsule over the upper surface above the gall-bladder site was white and thick.

The gastro-intestinal tract was apparently normal. At least there was no evidence of tumor. Mesenteric nodes were not enlarged. Pancreas and suprarenals were normal.

The right kidney was present as a sac described above. On section it was thin walled. There was scarcely any grossly evident parenchyma. The wall in its thickest area was not more than .5 cm. The interior was loculated, lining was thick, white, mottled with smudges of dark red. The surface was smooth. The ureter was dilated to a diameter of 1.5 cm. within 2.5 cm. of the bladder. At this point, on opening, a papillomatous tumor was found whose base was 1 cm., the villous mass 2 cm. long projecting up into the lumen of the dilated ureter. From this point to the bladder the ureter was not recognizable. Just above this mass were several minute papillæ. The bladder orifice was an irregularly depressed area giving an appearance of scarring. The left kidney was enlarged. On section the cortex was somewhat broader than normal but the parenchyma seemed normal. This ureter was not involved. In the bladder, however, just below the orifice of the left ureter there was another papillomatous mass with a base of 1.5 cm. Just above the urethral orifice were several minute papillomata. The bladder cavity was greatly reduced. There seemed to be little bladder above the somewhat dilated trigone. The bladder wall was moderately thick. The mucosa was trabeculated.

The prostatic urethra was clear. The prostate and seminal vesicles were normal. In the left kidney there was an occasional small focus of interstitial fibrosis in the outer cortex. The average size of the glomeruli was a trifle larger than normal, otherwise there was no significant change.

The right kidney was reduced to a thin layer of parenchymal remnants sandwiched between two thick layers of fibrosis, one layer the fibrosed capsule to which the suprarenal was densely adherent. The other layer was the older inflammatory connective tissue forming the basis for a rather thick pyogenic membrane lining the kidney cavity. The pyogenic membrane was quite vascular and there was considerable blood pigment. The parenchyma consisted of scattered dilated tubules and a few glomeruli, most of which were completely fibrosed.

The bladder tumor was a typical papillary squamous cell tumor, the delicate vascular stroma for the most part covered by thick layers of cells which were usually spindle shaped at the stroma but in the centers of the thicker masses definite pavement cells. There was very little mitosis and it was considered of Grade I malignancy.

The ureteral tumor was almost identical with the tumor in the bladder except that the villi were not so robust nor the epithelial covering so thick, so there was less tendency to definite squamous change in the cells. There was, however, just a little more activity in growth. It might be classed as Grade I malignancy.

It is to be noted that very likely there was inflammatory condition in the right ureter leading to its stenosis independent of the presence of the tumor in the ureter. It is possible that the epithelium of this subsequently dilated ureter assumed more the character of bladder epithelium. Certainly the two tumors were practically the same.

There were some perivesical adhesions anteriorly but there was little difficulty in removing the bladder from the pelvic structures.

Anatomical diagnosis was: (1) papilloma of the bladder; (2) papilloma of the right ureter with obstruction; (3) pyelo-hydronephrosis, right.

DISCUSSION

There are several points of considerable interest in the case here reported. There is a definite history of intermittent hematuria covering a period of twenty-five years previous to coming under observation. This is exceptional. The longest period we have noted in the reported cases is 14 years.

The low grade malignancy of the bladder growth is shown both clinically and histologically. It belongs, therefore, to the so-called benign papilloma group of tumors. This patient was under observation at intervals for a period of eleven years. The actual period of bladder involvement was much longer from the fact that a large tumor was found at the first examination and from the further fact of the long history of hematuria. During this prolonged period the character of the growth did not change. It showed no tendency toward undergoing so-called malignant degeneration. The original tumor presented the clinical characteristics of papilloma. Recurrences took place in various parts of the bladder, not at the site of the original growth. The histological examination of the tumor found at autopsy showed the type of cell structure usually found in papilloma. This observation appears to confirm the view that the type or character of cell in these papillary tumors does not change. If the original tumor is "benign," any recurrence that may develop will have the same characteristic.

In border line cases it is quite impossible, at least in our experience, to make a correct differential diagnosis between so-called benign papilloma and papillary carcinoma of the bladder on cystoscopic examination. I have recently seen the most innocent looking papillary growth about the right ureteral orifice, readily removed by fulguration, recur with such startling rapidity and persistency as to get out of control and go on to widespread metastasis. On the other hand, another recent case of extensive recurrence following a wide segmental resection of the bladder was completely destroyed by fulguration in six seances. In the first case the original tumor was undoubtedly malignant, but the cystoscopic appearance was that of a small, "benign" papilloma. The second case illustrates the fixity of cell type in that the original growth was of low grade malignancy, so-called benign

papilloma, and a massive recurrence readily yielded to fulguration. Cystoscopically, however, such a differentiation was impossible.

Furthermore, it is interesting to speculate on the etiology of the ureteral tumor and its relation to the recurrent bladder growths. The bladder tumor appears to have been primary. We cannot say positively that there was no tumor of the ureter at the time the patient came under observation, as a routine examination of the kidney, including catheterization, was not made and did not appear to be indicated in the absence of symptoms referable to the upper urinary tract. Symptoms referable to the kidney did not develop until nearly three years later—pain in the renal area—at which time a general physical examination failed to show any evidence of kidney involvement. It was not until eight years after our first operation upon the bladder that a definite lesion of the kidney was suspected—enlargement revealed by palpation. In the meantime the patient had complained on one occasion of severe pain in the other (left) kidney with negative findings on general examination at the time, and no lesion was found subsequently on this side. It seems fair to assume, therefore, that the tumor in the right ureter developed several years subsequent to the vesical growth.

How, then, are we to account for its development and location? And what was the relation to the primary vesical growth? Was it an independent, isolated tumor developing in a patient exhibiting a marked tendency to papillomatosis, or did it result from implantation or metastasis? It is difficult to understand how direct implantation could have occurred, since instrumentation of the ureter, which might have been responsible, was never done. There remains the possibility of ureteral reflux occurring before obliteration of the ureteral lumen. Under these circumstances, we would hardly expect a solitary tumor to develop, but, rather, multiple growths occurring at different levels. It seems to us more likely that the ureteral papilloma was independent in its origin and was secondary only in the sense that it developed subsequent to this bladder tumor. The same type of epithelium, transitional, lines the bladder, ureter, and renal pelvis. There is no apparent reason why the same type of tumor may not develop independently in either of these structures. As a matter

of fact, papillary growths, as already noted, are very common in the bladder, relatively rare in the renal pelvis, and occur much more rarely in the ureter. The reason for this difference must be sought in some local condition the nature of which still remains unknown.

ANALYSIS OF CASES

An analysis of the thirteen additional collected cases shows the following:

There were eleven males; two females. The youngest was twenty-four years of age; the oldest sixty-five years. There were five under fifty years and six over sixty years. The tumor was single in nine cases; multiple in four.

Hematuria was the presenting symptom in eight; in six this was symptomless; in one it was associated with renal colic, and in one with pain at the costovertebral angle and an abdominal mass the size of a child's head. In another case with a large abdominal mass there was a history of hematuria two years before. In Viethen's case the only complaint was a slight discomfort in the left kidney region; there was a complete absence of hematuria either before or during observation. Bleeding appeared first after repeated attempts to pass a ureteral stricture.

The kidney was definitely hydronephrotic in five cases; the pelvis and ureter were dilated in two others.

In one case the ureter was completely plugged by a growth at its vesical orifice (Cassuto) and the kidney was "badly diseased." A subsequent nephrectomy was done. Definite ureteral obstruction was noted in six cases and may be assumed in two others, in one of which there was a hydronephrosis while in the other the kidney was "markedly enlarged."

A projecting ureteral tumor was found at cystoscopy in seven cases. In only one of the remaining six was a definite, correct preoperative diagnosis made (Huc). In this case there was a history of hematuria for a period of two years, uninfluenced by rest. There were no associated symptoms except generalized lumbar uneasiness. Cystoscopy revealed a normal bladder with bleeding from the left ureter. The catheter obstructed at 16 cm. Attempts to pass the stricture increased the hemorrhage. The obstruction was finally passed and the bleeding ceased. The

diagnosis in the other cases was: kidney tumor (Kleinschmidt), papilloma of the renal pelvis (Kraft), closed hydronephrosis (Walker), not stated (Bates, Löffler).

The diagnosis of tumor of the ureter appears to offer unusual difficulties and is rarely made when the growth is situated well above the ureteral orifice and therefore not visible on cystoscopic examination. Gottlieb has suggested the following classification from the standpoint of diagnosis:

1. Those in which no tumor is seen either in the bladder or ureteral orifice.
2. Those in which a tumor is presented at the ureteral orifice.
3. Those cases in which hematuria recurs after nephrectomy for tumor of the renal pelvis (Kraft, Marion, Culver).

Diagnosis in the third group offers the least difficulty as the kidney source of the bleeding is already ruled out. If, however, there is a tumor present in the bladder the ureteral source of the bleeding may be easily overlooked unless a careful inspection is made during a period of active hemorrhage. The difficulties in such a situation are well illustrated in Marion's case, where multiple recurring polyps of the bladder were destroyed by fulguration during a period of three years. Finally a large polyp was found at the left ureteral orifice three months after the last fulguration of three small polyps occurring in different parts of the bladder. A ureterectomy was done and the excised ureter was found to be studded throughout its length with papillomata. A nephrectomy had been done five years before for multiple polyps of the kidney pelvis and upper ureter.

In the second group the diagnosis is concerned with establishing to what extent the ureter is involved—number and location of the tumors—and whether or not these are primary or secondary to growths of the renal pelvis.

It is in the first group that preoperative diagnosis is rarely made. At operation, even, the condition is easily overlooked. Aschner refers to two operated cases, one a nephrotomy and the other a nephrectomy and an exploratory cystotomy, in which the lesion was missed and discovered later at autopsy. Löffler nearly missed the tumor in his case. The kidney on exposure appeared normal. A very slight dilatation of the upper ureter suggested freeing this downward. It became normal in size 7

cm. below the pelvis, but 2 cm. lower a striking dilatation was found containing the tumor.

The symptom complex of hematuria, enlargement of the kidney, and pain, appears as the result of a variety of lesions of the upper urinary tract. By routine urologic study, one can usually rule out the more common conditions such as stone, tuberculosis, and stricture. Much more difficulty is experienced in differentiating solid tumors of the kidney, papillary growths of the renal pelvis, and ureteral tumors. From an analysis of the published cases it appears that the diagnostic criteria of greatest value in this group are:

1. The presence of an obstruction in the ureter.
2. Increase in hemorrhage on contact of the catheter with the growth.
3. In case the obstruction is passed by the catheter, the flow of clear urine from a point above the obstruction.
4. Filling defects in the ureterogram.

In the case of small growths there may be no obstruction to the ureter catheter (Dosza). In most cases, however, an obstruction is encountered and this is of significance only in demonstrating definite ureteral pathology.

Of much greater significance is the increase of hemorrhage following contact of the ureter catheter with the tumor. The vulnerability of the soft, villous growth and its marked tendency to bleed on catheterization led to a correct diagnosis in the case of Beer and Huc. Kraft made the interesting observation in his case of hemorrhage from the left ureter during cystoscopy after deep palpation over the lower left abdomen. Profuse hematuria had been noted previously in the same patient following a vaginal examination.

Enlargement of the kidney, the result of back pressure and dilatation from obstruction of the ureter, focuses attention upon the kidney. The primary source of the trouble in the ureter may be easily overlooked, especially if the obstruction is readily overcome by ureter catheter, and may be attributed to the more commonly occurring conditions, stricture, kink, stone.

Unquestionably ureterography is one of the most valuable differential diagnostic methods we have. Filling defects in the ureterogram have been helpful in arriving at a positive diagnosis in certain cases (Key and Akerlund). It is somewhat sur-

prising, however, that this valuable diagnostic aid has not been used more frequently in recently published cases. Routine ureteropyelography should be carried out in every case of unilateral upper tract hemorrhage where the cause of the bleeding is not made clearly evident by other means. A positive diagnosis of primary tumor of the ureter is one of the most difficult in urology. As in many other conditions, probably the most important step in the diagnosis is to suspect the lesion. It then calls for the keenest diagnostic acumen and the application of all the various diagnostic means at our disposal. Repeated examinations are generally necessary, during the period of active hemorrhage and in the interval between attacks, to complete the diagnosis.

The case here reported together with a few others from the literature, notably Marion's case, suggest the importance of bearing in mind the occasional association of tumor of the ureter and vesicle papilloma. It would hardly seem necessary to subject every patient presenting a papillary growth of the bladder to a routine examination for a possible tumor of the upper urinary tract. One must be alert, however, to the possibilities in any particular case. Even the slightest symptom referable to the kidney demands investigation. Cystoscopy should be done, when possible, during a period of active hemorrhage and a careful meatoscopy should be made to rule out the ureters and kidneys as the possible source of the bleeding even though the presence of a vesicle growth appears to explain adequately the cause and source of the blood.

TREATMENT

A papillary tumor of the ureter either primary or secondary is a serious lesion. Opinion has differed somewhat as to the best method of dealing with the situation. Nephrectomy with partial ureterectomy has been most frequently employed. Recurrences in the lower segment of the ureter have been frequently observed. Beer carried out his technic of aseptic nephro-ureterectomy in his case of primary papilloma and emphasized the importance of complete removal of the ureter in order to prevent recurrences. This principle is now generally accepted. The condition of the patient may make it necessary to do a two-stage operation.

In a recent paper, Hunt states that a review of the cases of papillary epithelioma of the renal pelvis at The Mayo Clinic showed bladder metastasis in two-thirds of the cases. Nephrec-

tomy with partial ureterectomy is sufficient for other forms of malignant tumors of the kidney, but was found insufficient in cases of papillary epithelioma, even when the ureter was removed at the base of the bladder. Experience has taught that the intramural portion of the ureter must be removed. Up to the present time, no recurrence has developed in cases in which this technic was employed. The tendency has been, therefore, to employ more radical measures in dealing with papillary ureteral tumors. And this appears to offer the surest guarantee against recurrence.

BIBLIOGRAPHY

A complete bibliography accompanies the papers of Aschner, Meeker and McCarthy, and Rousselot and Lamon. The following include only references not appearing in the above lists.

CARCINOMA

KEY, E., and AKERLUND, A.: Diagnosis tumors of ureter. Deutsch. Ztsch. f. Chir., 1927, 200, 428-444.

MCCOWN, P. E.: Primary carcinoma of ureter. Jour. A. M. A., 1930, 94, 468 (Feb. 15th).

PLAYER, L. P.: Primary ureteral carcinoma with case report and a review of the literature. Urol. and Cut. Review, 1928, 32, 438.

VOLANTE, F.: Primary cancer of ureter, case. Arch. ital di urol., 1927, 4, 105-132 (Dec., 1927).

WALKER, J. W. THOMPSON: (Case 2) Four cases of growth of the ureter. Proc. of the Royal Soc. of Med., 1920-21, 14, Part III, Section of Urology, p. 25 and p. 42.

MIXED TUMORS

BINDER: Zieglers Beitr., 1921, 69—Quoted by Kleinschmidt.

DJEAH-YÄN (WÄTJEN): Ein beitrag zur Kenntnis der primären Ureter-tumoren. Centralbl. f. Allg. Path. u. path. Anatom., 1924-5, 35, 549.

PAPILLOMA

ASCHNER, P. W.: Primary tumors of the ureter. Surg., Gyn. and Obst., 1922 (Dec.), 35, 749.

BASTOS, H.: Ein Fall von Primärgeschwulst des Harnleiters. Multiple gutartige papilläre Fibroepitheliome. Heilung durch Nephroureterectomia totalis A. med. contemp. 39, No. 44, 345 bis 350 Referat: Ztsch. f. Urol. Chir., 1922, 9, Ref. 361.

CASSUTO, A.: Uropyonephrosis due to papilloma of ureteral meatus. Lyon Chir., 1927, 24, 253-256.

DOSZA, E.: Weiterer Beiträge zur Kenntnis der Zottengeschwülste Nierenbeckens und Ureters. Ztsch. f. Urol. Chir., 1927, 22, 81 (Cases 1 and 3).

FJODOROFF (Quoted by Gottlieb): Chirurgie der Nieren. 5 Aufl., 1925.

GOTTLIEB, J.: Ueber Neubildungen des Harnleiters. Ztsch. f. Urol. Chir., 1926, 20, 230-242.

HUC, E.: Un diagnostic d' hematuria; le polyp d l' uretére. Paris Med., 1924, 53, 120-122.

KLEINSCHMIDT, R.: Beitrag zur Kenntnis der primären uretertumoren. Deutsch. Ztsch. f. Chir., 1925, 191, H ½, 103-107.

KRAFT, S.: Fälle von primärem und Sekundäm ureterpapillom. Ztsch. f. Urol., 1922, 16, H. 9:385, 392.

LÖFFLER, L.: Bericht ueber Einen Fall von primären Ureterpapillom. Ztsch f. Urol. Chir., 1925, 17, 370.

MEEKER, L. H., and MCCARTHY, J. J.: Primary carcinoma of the ureter. Jour. Am. Med. Ass'n, 1923, 81, 104.

ROUSSELOT, L. M., and LAMON, J. D.: Primary carcinoma of the ureter; report of a case and a review of the literature. Surg., Gyn. and Obst., 1930 (Jan.), 50, 17.

VIETHEN: Fall von primärer Neubildung am Ureter. Ztsch. f. Urol., 1927, 21, 605.

WALKER, J. THOMPSON: (Cases 1 and 3) Proc. of the Royal Soc. of Med., 1920-21, 14, Part 3, Section of Urology, p. 25.

GRANULOMA OF THE URETER

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The occurrence of granulomata in the urinary tract, in association with chronic inflammatory processes, is perhaps more common than is generally recognized. The publication of the paper of Braasch and Hurley before this society in 1927, emphasized the frequency and importance of these lesions. Only the other day, in a man suffering from bilateral calculous pyonephrosis, the bladder was found to be studded with small flesh colored patches, slightly raised, not unlike papillomata, though inflammatory in character. The accidental finding of a comparatively large and solitary granuloma in the upper ureter, in the course of a pyelolithotomy operation, where the suggestion of neoplasm was strong enough to prompt its operative removal by resection of the ureter, has induced us to present the case before the society, not only because of the rarity of the finding and the confusion of the lesion with neoplasm which arose, but also on account of the postoperative complication of massive pulmonary collapse which followed.

Braasch defines granulomata as "localized areas of hyperplasia of the mucosa and submucosa, resulting from inflammation." They vary from minute granulomatous patches in the mucosa to polypoid proliferations, most commonly found in the urethra and bladder. They may cause profuse bleeding, favor the persistence of infection and are easily confused with neoplasms.

Occurring in the renal pelvis, the condition has been described as pyelitis granulosa. Chiari was the first to study the condition from the viewpoint of pathological anatomy. He sought to prove that it was due to the presence of small areas of lymph tissue in the mucosa of the urinary tract. This view has been contested by most other pathologists, notably by Stoerk, who looks upon the condition as due to an accumulation of round cells without attempting to explain their round character and their symmetrical distribution.

Paschkis divides the condition into two groups—pyelitis granulosa, arising from the accumulation of round cells of inflammatory origin, and pyelitis follicularis, true lymph follicles with all their characteristics, such as germinal centers. The two are frequently found in association.

Przewoski has made a comprehensive study on sixty-three cases obtained at autopsy.

The pathologico-anatomical studies are more numerous than the clinical. The latter have been collected by Baetzner and comprise reports by Guyon, Taddei, Loewenhardt and von Frisch.

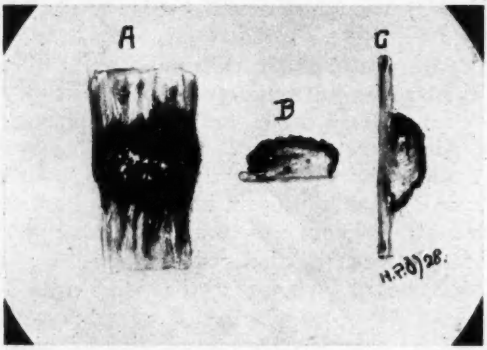

Fig. 1. Photograph of a drawing made immediately after the operation. *A*, Section of the ureter removed which has been opened to show the lesion. *B* and *C*, longitudinal section through the granuloma and ureter.

The last named came to the conclusion that pyelitis granulosa was an independent disease characterized by copious hemorrhages and that gonorrhea played a rôle in its production. Baetzner concluded it was not an independent disease, but was merely a pathological finding, denoting a special inflammatory process in the urinary tract, characterized by circumscribed round celled infiltrations occurring as nodules. Baetzner advanced a view that typhoid fever was an etiological factor, on the ground that his patient had typhoid fever previously, with urinary symptoms dating from the disease. In several of the reported cases there was a history of typhoid fever. In one of Przewoski's the patient died of typhoid, with acute urinary symptoms

developing during the disease. In three cases of typhoid pyonephrosis, for which nephrectomy has been performed by the author, this form of inflammation was not found. Loewenhardt advanced syphilis as an etiological factor.

CASE REPORT

Boy, aged ten years, was admitted January 19, 1928, complaining of attacks of pain in the left kidney region. His first attacks

Fig. 2. Low power microphotograph through the surface of the granuloma and underlying tissues. Note the absence of epithelium and superficial ulceration at *A* and the infiltration of tissues with lymphocytes.

occurred in August, 1927, were fairly severe, radiated downwards and lasted about one hour. The last two were more severe, with fever and nausea and vomiting. There were no other urinary symptoms. Hematuria had never been noticed.

The boy had had measles and mumps and two years previously he fractured his pelvis in a motor accident. There had been no bladder injury, and he had never had typhoid fever.

Examination of the heart and lungs was negative. The right

kidney and spleen were palpable. Cerebrospinal system was normal. Tonsils were enlarged.

X-ray examination revealed a shadow in the left renal area.

Urinalysis report was: Albumin +, three to five pus cells and two to four red blood cells per high power field.

Cystoscopic examination was made January 20, 1928, under gas-

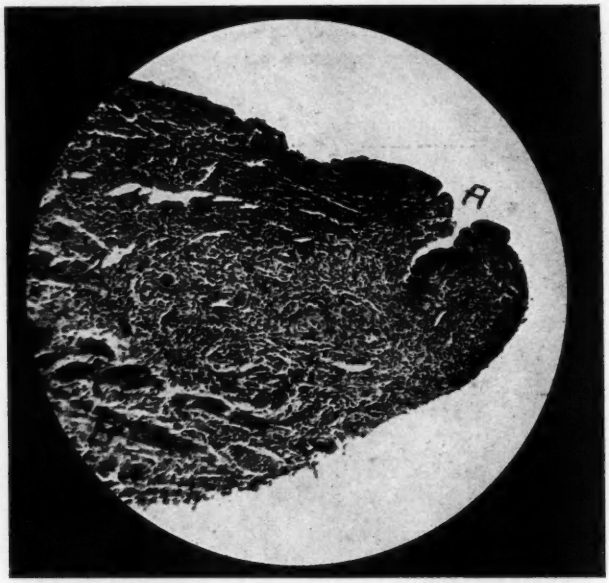

Fig. 3. Low power magnification of the border of the granuloma. Note the ulcerated surface and crypt formation at *A*, infiltration with lymphocytes and muscle of the ureter at *B*.

oxygen anesthesia. There was atresia of the meatus. Meatotomy was done to permit introduction of a No. 18 French cystoscope, single catheterizing. The bladder was normal. The right ureter was catheterized, but the flow was capricious and the catheter was withdrawn. A second catheter was passed up the left ureter and a urine specimen obtained which contained a few pus cells and red blood cells, about the same quantity as in the bladder specimen. No functional tests were made. Pyelograms were taken of the left kidney pelvis, in the antero-posterior and lateral positions, 5 c.c. of 12 per cent sodium iodid being injected. The pelvis was in-

completely filled, with vague outlines, slightly dilated, the shadow in the line of the catheter. In the lateral position, the shadow was in the line of the catheter, lying on the vertebræ.

Diagnosis was nephrolithiasis, slight hydronephrosis, left. There was an impression that the hydronephrosis was bilateral, presumably of congenital origin.

Fig. 4. High power of Figure 3. The ulceration and outlines of the crypt are readily distinguishable. There is marked lymphocytic infiltration of the tissues.

Operation was perfomed January 23, 1928. Under gas-oxygen anesthesia, the left kidney was exposed by an ordinary lumbar incision. The pelvis was moderately dilated and the stone easily removed through a small incision in the posterior aspect of the pelvis. The opening was closed loosely with one catgut suture. Palpation of the ureter revealed, at a point about 5 cms. below the uretero-pelvic junction and inside its lumen, a small mass about the size and consistency of a pea. It was not movable, apparently attached by one side to the ureteral wall. An incision was made in the ureter opposite the point of attachment. A small rounded tumor mass 1 cm. in diameter was everted. The pathologist summoned in consultation thought it was a neoplasm, although close

to the mass above it, on the ureter, were noted a few minute "granulations." In view of our impression that a bilateral hydronephrosis was present, no radical treatment seemed wise, and it was decided to excise the section of the ureter containing the suspected tumor, and do an end-to-end anastomosis. Two and one-half centimeters of ureter were excised and the two ends approximated loosely with fine catgut sutures. Cigarette drainage was used and the usual muscle closure was made.

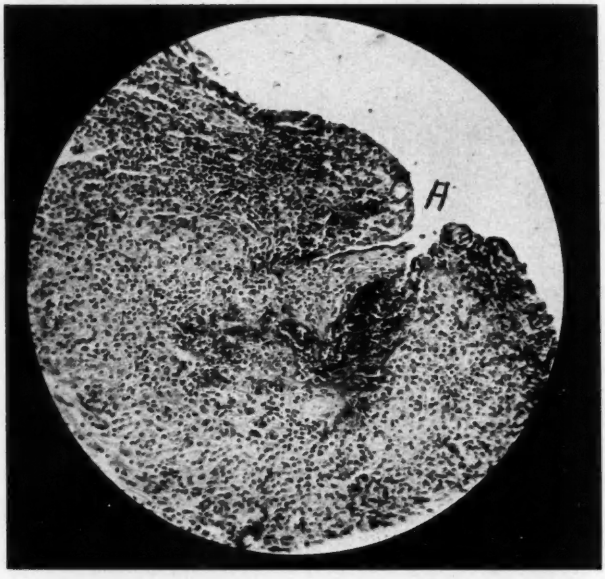

Fig. 5. Still higher power of Figure 3, showing ulceration, crypt formation and lymphocytic infiltration.

The subsequent course was tempestuous. Shortly after operation, the respirations were 40. The following day, the temperature rose to 105° (rectal). Examination by an internist showed marked diminution of respiratory movements on the right side of the chest, marked tympany on the right side, and hyperresonance on the left side and displacement of the heart to the right side. An X-ray of the chest taken the following day showed indistinct shadows over the right side, with marked displacement of the heart and trachea to the right, tending to confirm the internist's diagnosis of massive collapse of the right lung with pneumonia of the right lower lobe.

This condition gradually corrected itself. Clinical signs and cough were still present until his discharge from hospital thirty-three days after operation. Temperature gradually subsided and was normal twenty-three days after operation. The cough still persisted on his discharge.

The wound itself gave less trouble. A urinary leak occurred after a few days. A cessation of the leakage was followed on the

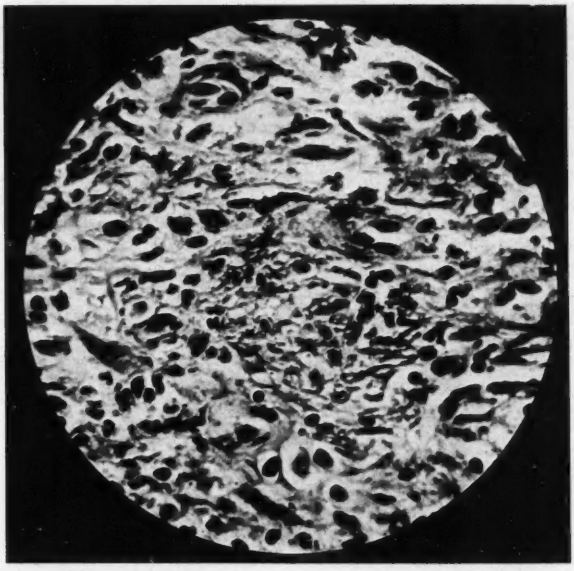

Fig. 6. Microphotograph to show the type of infiltrating cells in the granulomatous area. Note that the majority of them are lymphocytes.

twelfth day by a local discomfort, relieved by opening the wound with forceps and liberating a collection of purulent urine. The wound was dry on the twenty-third day. Pyuria increased after operation, but was down to 25 cells per high power field at the time of the patient's discharge on February 25, 1928.

Following the operation, the boy rapidly regained normal health. His parents and physician now report his general health as being greatly improved. There have been no symptoms of any kind. Examined recently, the urine showed a few pus cells. It has not been possible to obtain subsequent pyelographic studies.

Pathological report was made by Dr. L. J. Rhea.

The specimen (M. G. H., S-28-101) was obtained at operation. A drawing was made of it, and sections taken at once.

The specimen was a resected portion of the ureter 2.6 cm. long. It had been opened longitudinally. Projecting from the mucous surface for a distance of 0.8 cm. there was an encircling, elevated, greyish white, granular, irregularly outlined area which was bordered by a narrow zone of mucous membrane. The lesion, which was very definitely firmer than the normal ureter, but was not as firm as carcinoma or tuberculosis, was seen to extend deep into the ureteral tissue. The general character of the lesion and its relations to the ureter were best seen in the longitudinal section of the entire specimen.

Microscopical description of the lesion showed it to be of the nature of a granuloma. The mucous membrane covering it was almost completely absent and in places fibrin was adherent to the surface. At still other situations there were crypt-like, penetrating ulcerations which contained necrotic material and extended for some distance into the underlying tissue. The greater part of the lesion was made up of a diffuse infiltration of lymphocytes, plasma cells and an occasional eosinophile. Most of the lymphocytes were of the small type. In the superficial portion of the granuloma, infiltrating cells occurred between strands of fibroblasts and thin-walled dilated capillaries, while deeper in the lesion they occurred in the preformed tissues of the ureter. No germinal centers were noted in the areas of lymphocytic infiltration. There was no evidence of true tumor or tuberculosis. No definite eitology was established.

Diagnosis was granuloma of the ureter (non-specific).

COMMENT

As regards the operative procedure in this case, it is difficult to see in what other manner the granuloma could have been successfully dealt with, than by ureteral resection, even if the confusion with neoplasm had not been present in our minds at the time of operation.

As regards the etiology of granulomata in the urinary tract, there do not appear to be any grounds for regarding them as other than a non-specific inflammatory lesion.

During the past few years there has been an increasing interest in a pathological condition of the stomach, gastritis follicularis, a condition characterized clinically by repeated severe hemorrhage, giving a picture that is indistinguishable from peptic ulcer. Pathologically, it is very similar to that variety of granuloma in the pelvis which Paschkis has described as pyelitis fol-

licularis. It is quite possible, therefore, that some of the so-called essential hematurias may be due to a similar condition.

BIBLIOGRAPHY

BRAASCH and HURLEY: Trans. of the Amer. Assoc. of G-U. Surg., XX, 1927, 29.
BAETZNER: Ztschr. für Urol. Chir., I, 1913, 285.
CHIARI: Wiener med. Jahrbücher, 1881, quoted in Baetzner, loc. cit.
FITZGERALD, R. R.: Personal communication.
LOEWENHARDT: Archiv. für Dermat. und Syph., LXXXIV, 1907, 395.
PASCHKIS: Folia Urologica, VII, 1912, 55.
PRZEWOSKI: Virchow's Archiv., CXVI, 1889, 516.
STOERK: Ziegler's Beiträge zur pathologischen Anatomie und zur allgemeinen Pathologie, XXVI, 1899.
VON FRISCH: Verhandlungen der Deutschen Gesellschaft für Urologie, 1909, quoted in Baetzner, loc. cit.

EXTRA-URETERAL CONDITIONS LEADING TO INCORRECT DIAGNOSIS OF URETERAL STRICTURE

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The literature has been replete with enthusiastic articles concerning the subject of ureteral stricture and its treatment by repeated progressive dilatation. This school, so to speak, has arousd considerable dissension, even animosity, among a large group of urologists who deny the existence or the advisability of dilating stricture of inflammatory origin. Still there has been little written upon this view of the subject.

No satisfactory demonstration of infiltration or deposition of fibrous tissue within the ureteral wall, to so prove the existence of inflammatory stricture, has been made; yet, this fact does not constitute sufficient grounds upon which to refute the brilliant clinical response obtained by dilatation in many patients.

Some years ago I had great difficulty in obtaining consent from a patient to remove an impacted calculus from his lower right ureter, unless I agreed also to remove his appendix. This attitude came of the fact that eleven different physicians had diagnosed appendicitis at various times in the past.

At that time little was known and less thought of the ureter by the rank and file of physicians. Of late years my observations lead me to believe the profession has become strongly "ureter-minded." Likewise, I believe the ureter is receiving more than its share of attention and much unwarranted diagnostic tampering and ill advised treatment by dilatation.

It behooves the urologist to be a bit wary, and, though he be not a skilled general diagnostician, to satisfy himself concerning the state of the gall bladder, appendix and pelvic organs of both sexes, before deciding on a diagnosis and dilatation of ureteral stricture. Both ureterographic evidence and so-called "hang" to the bulb bougie may be very misleading.

The lack of evidence of infiltration and fibrosis in the ureteral

walls at the site of alleged strictures can be readily explained by peri-ureteral infiltration and fibrosis from extra-ureteral contions involving adjacent structures. Assuming this peri-ureteral fibrous deposit to be slight or moderate in its density, ureteral constriction might readily be relieved by judicious dilatation. It is likewise obvious that intra-ureteral dilatation is unlikely to influence permanently dense and extensive fibrosis surrounding limited areas of the ureter. Obstructions are common at each extremity of the ureter. Near the ureteropelvic junction, anomalous vessels to the lower pole not uncommonly produce serious ureteral obstruction. Also distortion and contracture of the ureter by firm adhesion to the lower portion of the kidney pelvis following severe intrapelvic inflammation is frequently found as the basis of hydro- and pyonephrosis.

Ureteral constriction so frequently found in the intramural ureter is often associated with a greatly thickened, hypertrophied or infiltrated bladder wall, the product of lower tract obstruction or severe chronic cystitis. This condition converts the normal valve arrangement into a sphincter. It is obvious that intra-ureteral dilatation is unlikely to influence such pathology permanently, and equally probable that dilatation will so traumatize the ureteral wall when a dilating instrument is forced by an undilatable peri-ureteral fibrosis or constriction, that severe reaction and serious damage may occur. Hunner states 29 per cent of inflammatory strictures are curable, 65 per cent improved by dilatation, and 6 per cent unimproved.[1]

The stricture of the ureteral wall is entirely unlike that of the urethra, lacking the various glands and crypts and the spongy body surrounding it. Thus the ureter has not the fundamental basis for stricture formation found in the urethra. If interstitial cystitis, however, may involve the peritoneal covering of the bladder, it is equally conceivable that severe intraperitoneal inflammatory processes or trauma may leave in their wake extensive peri-ureteral fibrous infiltration with consequent impingement upon its lumen and interference with the normal peristaltic function and dilatability of the ureter. If simple inflammatory infiltration or stricture exists in the ureteral wall, there is no more reason why progressive dilatation should not cure than when a similar condition exists in the urethra. By the same token, when dense fibrosis surrounds the urethra we have an

equally undilatable condition. Are not the percentages classed "improved" and "unimproved" probably not true infiltrations of the ureteral wall *per se*, but extra- or peri-ureteral dense fibroses?

The intimate relation of the ureter to the seminal vesicles in the male, and all the generative organs in the female, provide unusual environment for its becoming ensnared in inflammatory or malignant processes.

In the postmortem study of eight cases in which stricture of the ureter had been diagnosed ante mortem, Hunner describes the condition mentioned above very clearly in several cases under the caption "Constrictions Due to Pressure of Surrounding Tissues."[2]

The following cases are of interest in exemplifying the foregoing statements and theories:

Case 1.—G. A. W., housewife, aged thirty-four years, was admitted June 13, 1929, complaining of pain in the right loin. Family history was irrelative.

The patient had had the usual diseases of childhood; typhoid at the age of ten years. At the age of fourteen she was sent to Colorado on account of suspicious lungs. There was no definite tuberculosis. Menses began at the age of fourteen, regular twenty-eight day periods of four to five days' duration.

At the age of eighteen the patient had an attack of pain in the right side lasting 4 to 5 days, diagnosed as appendicitis. She was well until four or five years previous, when she had intermitten attacks of pain in the right lower quadrant, worse on exercise and near menses. In the past three months soreness had been continual and aggravated at menses. There was pain in the right loin and costal iliac space. She had never vomited from pain. $\frac{\text{Dx3-8-10}}{\text{Nx0}}$ Frequency was by spells—no nocturia. She was always constipated.

Upon examination the right kidney was not palpable nor tender. There was decided tenderness on deep pressure in the right iliac fossa. Urinalysis was negative. Cystoscopy found the bladder normal and quite decided congestion at the apex of the trigone and urethral aspect of the sphincter. A No. 5 catheter passed easily to each kidney pelvis. Drip was normal and equal. Pyelo-ureterogram was negative. A No. 10 bulb found a sharp hang at the level of the broad ligament. Two dilatations were made with No. 12 and No. 13 bulbs at two-week intervals.

July 15, 1929, the patient stated that treatments were apparently

aggravating and increasing her pain. Abdominal palpation revealed a very tender spot over McBurney's point. Vaginal palpation revealed a retroverted fixed uterus, pressure behind the cervix producing excruciating pain, and it was definitely tender in the area of the broad ligament. The patient was advised to return to the referring physician for reference to a gynecologist or general surgeon for correction of the perineal laceration and pelvic condition. It was planned, if the symptoms persisted after this was done, to continue with dilatation of the ureter.

Operation was performed December 16, 1929. The uterus was retrodisplaced, firmly adherent, with adhesions in the posterior cul-de-sac. The adhesions were broken up. Both tubes and ovaries were normal. Shortening of the round ligaments was accomplished with silk suture by the pleating method. The appendix, which was very large, free and large at both ends, was removed.

The patient responded to a request for interview, and on April 24, 1930, stated she had no pain in the groin or lower abdomen, nor in the kidney region. She had severe pain in the right kidney for several days immediately after operation. She was also incontinent for five days. This would indicate irritation in the region of the ureter and bladder at operation.

Case 2.—M. P., bookkeeper, widow, aged forty years, was admitted December 15, 1929.

Her principal complaint was (1) pain in the right side and back, radiating down the groin and leg; (2) frequency and nocturia. Family history was irrelative.

Of childhood diseases she had had measles only. II para. She was well until the first childbirth, when she had to return to the hospital for removal of part of the retained placenta. Appendectomy had been performed eleven years ago; ovariotomy, right side, fourteen years ago; tube operated later. There had been no menses since these operations, and the patient had been well until the present illness.

The patient had an attack of what she supposed was ptomain poisoning with fever and pain in right side three weeks previous, also urinary frequency and vomiting. After getting about, she began to have severe pain in the right side, constant, then to back and down groin and legs. There was frequency of urination and nocturia. $\frac{\text{Dx6-8}}{\text{Nx3-4}}$

She had noticed nothing unusual in the appearance of the urine. There was no dysuria. She began to menstruate a few days before for the first time in nine years. She had had twelve dilatations of the right ureter invariably followed by severe reaction, with a short period of temporary relief of symptoms between treatments.

The right kidney, upon palpation, showed general fullness, and failed to relax. The left kidney was not palpable or tender. Urinalysis was negative. Cystoscopy showed the bladder and ureteral ostia normal. Sphincter was normal. A No. 5 X-ray catheter passed easily to each kidney pelvis; function 2.5 minutes, equal concentration dark blue both sides. A double pyelogram was made. There was a slight right pyelectasis and dilatation of the upper ureter. A No. 11 bulb catheter found a sharp hang at the level of the broad ligament. Specular examination revealed a normal vagina. The cervix presented two small openings on either side with a distinct septum, probably of inflammatory reparative origin. The right opening showed a moderate flow of menstrual blood. The left would not accept a small probe, while the right did. Bimanual palpation revealed the uterus enlarged to about the size of an orange, antiflexed and somewhat fixed. There was a good deal of brawny induration around the lower segment. There was an irregularly hardened mass to the right connected with the uterus. The patient was advised to consult a general surgeon.

Operative findings, January 3, 1930, showed that the omentum was adherent to the abdominal wall and coils of intestines. Many dense adhesions obscured the region of the right broad ligament. The right fallopian tube was bound down to the fundus of the bladder, and the right ovary contained a cyst the size of a hen's egg. The right ovary and tube were freed, excised, and all tissues and structures in the region of the broad ligament were separated and normal relations restored.

February 11, 1930, the patient still complained of the original pain. A No. 14 bulb bougie was passed easily to the right kidney pelvis, encountering slight resistance at the intramural portion, and again on February 15 a No. 15 bulb bougie was passed.

A recent communication from the patient states she has been entirely free from all pain and bladder symptoms to date.

This case seems to suggest that the symptoms were arising largely from the ureter, but were entirely incurable until the adhesions and pathological condition surrounding the ureter were removed, and it then required but two dilatations to correct the intractable condition formerly existing in the ureter.

Case 3.—H. F., housewife, married, aged twenty-seven years, was admitted January 7, 1930.

The principal complaint was (1) pain in the lower abdomen following urination, radiating up to the left kidney pelvis; (2) vaginal discharge and blood between periods. Family history was irrelative.

Past medical history was unimportant excepting that five years previously the patient had a "cyst" removed from the "mouth" of the uterus, and three years previous an abdominal operation with removal of cysts and some suspension operation of the uterus. This

operation failed to relieve her symptoms and she had fifteen ureteral dilatations which would give but temporary relief.

Coming to me with a history of this number of treatments, it was only reasonable to search for some other cause for the persistence of symptoms.

Inspection of the vagina revealed a large purple cervix. On bimanual pelvic examination the uterus seemed large and in normal ante-flexion. The region of the right broad ligament and adnexa were normal, while in the left there was a doughy mass which was very tender. Cystoscopy found the bladder normal except for slight trabeculation which indicated some obstruction at the vesicle neck. The urethra appeared somewhat contracted to substantiate this. A No. 12 bulb bougie passed up the left ureter and found a slight hang near the orifice.

It was believed that this patient had an infiltration or adhesions around the ureter, or pressure from some sort of mass, giving rise to the symptoms, rather than a ureteral stricture. She was advised to consult a general surgeon with this question in view.

Operation was perfomed January 25, 1930. The left tube was found sclerosed and the ovary cystic. These structures were densely adherent to the left pelvic wall, and in freeing them for excision, the ureter was exposed to view. Tissues around the ureter were freed.

A recent communication from the patient states "I have not had a pain since the day of my operation."

Case 4.—S. A., a novitiate nun, aged twenty years, was admitted April 16, 1929.

This was a most interesting case, wherein ureteral findings were very misleading, a young woman referred for pain in the right side in the region of an appendectomy scar, radiating up to the kidney area.

Family and previous history were unimportant excepting that an appendectomy for acute appendicitis had been performed six years previously. One month following this operation the patient began to have throbbing pain of an intermittent character in the right side. Recently it had been more constant, and since the previous fall had radiated up the side and through to the back, producing nausea and vomiting at times. $\frac{\text{Dx3-4}}{\text{Nx0}}$

Menses were at three-week intervals, 4 days each. There was no dysmenorrhea, but pain was aggravated during this period.

The abdomen was very tender over the right lower quadrant. It was not tender in the costal vertebral space, but the patient stated that this was the site of the pain. Cystoscopy showed the bladder to be normal. A No. 5 catheter passed easily to the left kidney

pelvis, but with firm resistance all the way up to the right kidney pelvis. Drip was normal and equal. Indigo-carmin appeared in three minutes on each side, with equally good concentration. A right pyelogram made. Pain was produced upon injection of 3 c.c. of sodium iodid. Pyelo-ureterogram showed no abnormalities. On account of the resistance of the No. 5 catheter, and the patient's stating that this seemed to reproduce her pain, it was felt that dilatation of the ureter was advisable and justified. She had a very severe reaction, however, with pain and vomiting, but returned in two weeks and a No. 6 catheter was passed with moderate resistance. This treatment was also followed with severe reaction, pain and vomiting. Two weeks later a No. 8 bulb bougie was passed to the right kidney fairly easily. No hang was encountered but the patient again suffered a severe reaction, and ⅓ gr. doses of pantopon frequently repeated reduced respirations to 12 per minute, but failed absolutely to control the pain. She had vomited every day excepting the day of examination.

Feeling that the severe reactions were indicative of ureteral constriction, and dilatation justified, a No. 10 olivary bulb was passed and found distinct hangs, one just below the uteropelvic junction, one at the brim of the pelvis, and one about 3 cm. from the ureteral orifice. Following this the patient had the most severe reaction of all, and, apparently frightened and discouraged, went home and consulted Dr. Donald Guthrie, who had performed the appendectomy six years previously.

A letter from Dr. Guthrie, answering my inquiry, states that he operated June 14, 1929, excising a neuroma in the cicatrix of the old appendectomy scar. He states the neuroma was easy to recognize before and after operation.

A recent communication from the patient states she has been absolutely without pain or symptoms since her operation.

This case shows how far from the true source of actual pathology one may be led by over-enthusiasm to find ureteral stricture.

Without reporting in detail, I wish to mention several cases of undoubted incomplete obstruction of the lower ureter in the male which failed to respond to dilatation until appropriate treatment was applied to seminal vesiculitis with extensive perivesicular infiltration.

To substantiate the statement that serious damage may be produced by unwise dilatation of the ureter, I have twice been called upon to relieve urinary extravasation in the loin, and subsequently perform nephrectomy to cure persistent infected urinary fistulæ. Both cases were the product of ruptured ureters by large bulb catheters or bougies in young women having no previous serious renal pathology.

REFERENCES

1. HUNNER, GUY L.: End-results in one hundred cases of ureteral stricture. Jour. Urol., 12, October, 1924.
2. HUNNER, GUY L.: The pathological findings in cases clinically diagnosed as ureteral stricture. Jour. Urol., 15, 1, January, 1926.

INFLAMMATORY OBSTRUCTION OF THE URETER CAUSED BY PSOAS ABSCESS, SECONDARY TO TUBERCULOSIS OF THE SPINE

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At Glen Lake Sanatorium, the Hennepin County institution for the treatment of tuberculosis, new data concerning the diagnosis and treatment of tuberculosis, together with many unusual pathologic specimens, are reported each year.

Patients sent to Glen Lake Sanatorium, where all types of tuberculosis are treated, sometimes remain for many years. This permits us to make repeated examinations and to watch lesions in the genito-urinary tract over long periods of time. In an attempt to evaluate our clinical findings and data obtained from urologic study, a postmortem examination is made, whenever possible. Gross specimens of the urinary organs are always saved for study, whether the patient has had genito-urinary symptoms or not. This routine postmortem examination of the urinary organs has been enlightening.

We are reporting herewith the histories and postmortem findings of two patients who had obstructions in their ureters which were parts of psoas abscesses originating in tuberculosis of the vertebræ. The obstruction was complete enough to destroy the kidney entirely, in one instance, and to produce a large hydronephrosis in the other. In neither was the unusual pathology suspected, and would not have been discovered without a postmortem examination.

CASE REPORT

The first patient was a woman, aged thirty-nine years, whose history indicates that at the age of twenty-one she had her first illness, an abscess developing over the spine. This opened spontaneously, but drainage was not sufficient and eventually a rib resection was done. For a time this sinus closed, and then a kyphosis developed.

No trouble was observed for three years. Then she complained

of pain in the right side of the back with some radiation to the right abdomen. The patient had an appendectomy which gave no relief from this pain, and left a gaping, infected wound which did not heal for several months.

During the patient's convalescence from the appendectomy, another abscess developed in her back which required multiple in-

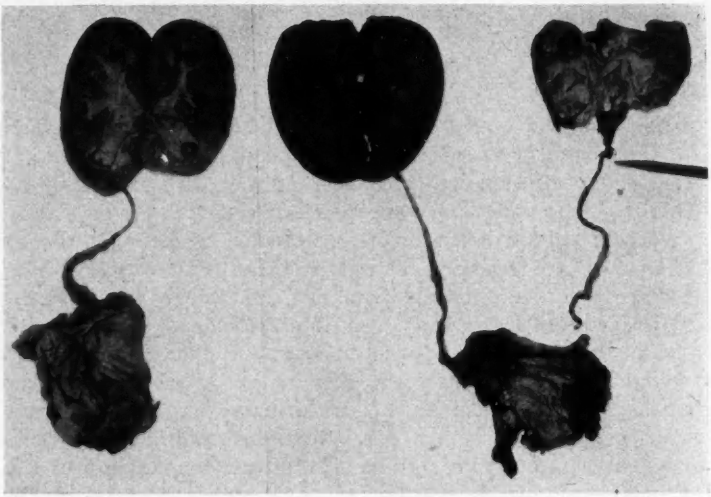

Fig. 1. *(Left)* Hydronephrosis produced by obstruction in upper ureter, the result of psoas abscess.

Fig. 2. *(Right)* Kidney totally destroyed. Hydronephrosis with obstruction in the ureter near the kidney the result of psoas abscess, opposite kidney normal.

cisions in order to improve the drainage. Chronically draining sinuses resulted which continued for many years.

In September, 1927, the patient had a severe cold, followed by a persistent cough. This continued until her admission to the sanatorium in April, 1928. At this time a thorough examination revealed the following lesions: (1) tuberculosis of the sixth to the twelfth dorsal vertebra, with draining tuberculous sinuses from the right posterior chest wall; (2) tuberculous empyema, right side; (3) some free fluid in the peritoneal cavity, probably peritonitis.

Repeated inoculations of the urine into guinea pigs were negative for tuberculosis.

Postmortem examination, made two years following the patient's admission to the sanatorium, revealed the following: There were

several sinuses, one about 3 cm. below the right nipple, another 8.5 cm. below the crest of the left ileum and 10 cm. posterior to the anterior superior spine. There were five scars of healed sinuses in the skin of the back.

An old pulmonary tuberculosis with empyema was found in the right chest. Chronic peritonitis was present and there was a tuberculosis of the fourth dorsal to the third lumbar vertebra with multiple sinuses. The right kidney, which was normal in size and weight, was bound down by firm fibrous adhesions. These were noticeable on the medial and anterior portions. Except for these adhesions, the right kidney and ureter seemed to be normal.

On the left side there were many adhesions which involved the entire kidney and the first 4 cm. of the left ureter. This kidney was markedly atrophic. There was a hydronephrosis which was produced by contraction of scar tissue about the upper ureter. Inspection of the left ureter below the obstructed area was negative. There was no gross or microscopic evidence of tuberculosis in either kidney. A sinus tract was discovered on the left side which began in the eleventh dorsal vertebra and extended to the scar tissue surrounding the left upper ureter and kidney. This was followed laterally and was lost over the left psoas muscle.

We reviewed the nurse's record and the patient's complaints appearing in the history and progress record without finding mention of attacks of pain which might be interpreted as coming from some condition obstructing the left ureter. Since this patient had back pain continuously because of the tuberculosis of the vertebræ, it is easy to understand why this symptom may have been misinterpreted.

The second patient was a male, aged twenty years, who was admitted to the sanatorium April 22, 1927, and died August 31, 1927, being under our observation for only four months.

On admission we found that this man had a bilateral parenchymal pulmonary tuberculosis, more noticeable on the right side than on the left. He had a positive sputum. Two months after admission he had a contracture of the left thigh and a palpable mass in the left abdomen. For several weeks before this abdominal mass was noted, the patient had complained of pain in the left leg and the left lumbar region. He had no genito-urinary complaints. Urinalysis of ten specimens of urine revealed only a faint trace of albumin. Only one contained a few leukocytes. Repeated Ziehl-Nielsen stains and frequent injections of urines into guinea pigs did not reveal evidence of tuberculosis.

A roentgenogram of the lower dorsal and lumbar spine showed marked destruction of the lower portion of the first and third

lumbar vertebræ. This latter shadow, we believe, was a psoas abscess.

A postmortem examination was made one hour following death. The anatomical diagnoses were Pott's disease of the lumbar spine, miliary tuberculosis of the lungs, kidneys and adrenals, with caseous tuberculosis of the lungs and adrenals. There was slight dilatation of the pelvis of the right kidney and there were many tubercles scattered throughout its cortex. The ureter on the right side was not involved in an inflammatory mass. On the left side there was marked dilatation of the pelvis of the kidney. The ureter was caught in a fibrous tissue mass which was part of a psoas abscess constricting the ureter and producing a hydronephrosis.

A review of this patient's history does not reveal complaints, symptoms or findings which might indicate a genito-urinary lesion. Like the former patient, this man had a great deal of pain in the left lumbar region which extended downward, and which we believed was produced by a large psoas abscess. If this patient had pain as a result of obstruction in his ureter, it probably was masked by the pains which were produced by the tuberculosis in the spine and the psoas abscess. Why the abscess on the right side did not involve the right ureter we do not know. We are unable at this time to find an anatomical reason why the left and not the right ureter should be involved, particularly in the last case, where bilateral psoas abscesses were discovered.

It seems evident from these reports that psoas abscess may involve the ureter, producing obstruction and thus destroying the kidney. In the cases which we report, this obstruction in the ureter was not associated with tuberculosis of the kidney. Urinary findings were negative. The history was not helpful in making a diagnosis of ureteral obstruction.

The conditions found had not been anticipated, and only the postmortem study made the true diagnosis possible. We shall consider, however, the possibility of obstruction of the ureter in all future cases of psoas abscess.

These reports are made with the coöperation of Drs. C. C. Van Winkle and L. E. Williams, pathologists at Glen Lake Sanatorium, who made the postmortem examinations and obtained the specimens.

DISCUSSION

DR. WILLIAM F. BRAASCH (Rochester, Minn.): The case reports by Dr. Fowler and Dr. Patch were of exceptional interest. They bring up the problem of differential diagnosis between primary and secondary tumors of the ureter.

Urography offers us a method which will enable us to recognize the condition present in most cases. With primary tumors of the ureter the area of the ureter involved is usually sacculated and there is evidence of ureterectasis extending a variable distance above it, usually only several centimeters. Evidence of pyelectasis is either absent or of secondary importance. With a primary tumor of the renal pelvis there is either definite pyelectasis or a variable degree of filling defect in the pelvic outline. The deformity in the pelvis is of primary importance. Deformity in the ureter from metastasis is usually moderate in degree and may even be absent when the growth is small.

If, however, the dilatation of the pelvis is in conjunction with evidence of tumor in the lower ureter, it necessitates surgical exploration of the pelvis in order to exclude the possibility of a primary tumor.

Of interest in these cases is the question of implantation metastasis in the bladder. Personally, I believe that the neoplasm found in the bladder in Dr. Fowler's case came from a mother tumor in the ureter and was not a papillomatosis as he suggested. There is no reason why a primary tumor in the ureter should not be followed by metastasis in the bladder just as often as with primary tumor in the pelvis of the kidney. A case of that type was recently brought to my attention in a physician who had multiple tumors in the bladder secondary to a primary tumor in the lower ureter.

A ureterogram showed a definite tumor in the lower ureter which was resected. Microscopic sections made from this tumor were similar in nature to those made from the small metastases found in the bladder.

With respect to the granuloma that Dr. Patch reported, this condition is one of intense interest. It would seem that it should not be necessary to operate for granuloma and in extreme cases to remove the ureter and the kidney. It has been my experience, however, that the usual treatment consisting of local applica-

tions or ureteral dilatation is not usually of much help in these conditions. It is also quite difficult to employ cautery or radium or to make a local resection. The possibility of resection with end-to-end anastomosis may be applicable with small granulomata, but hardly when extensive.

DR. FRANCIS R. HAGNER (Washington): I want to say just a few words concerning Dr. Paine's paper. I think it is a valuable thing to bring up at this time, because I think we have all had experience with cases that have been diagnosed ureteral stricture.

I recall a case two years ago of a woman who had been diagnosed in another city as having ureteral stricture. She had had recurrent attacks of pain, usually beginning low down and extending up into the right flank. Her physician was in a city near Washington, and he was firmly convinced that she had ureteral stricture and that this caused her symptoms. I personally have never been able to understand, when a patient has ureteral stricture, if there is no retention in the kidney pelvis, why pain should be present.

I saw this patient in severe pain, with a slight rise of temperature, pain beginning low down and extending up into the kidney region. The ureter was catheterized, normal urine obtained, and no retention in the pelvis. The examination was made in the patient's home, so we did not have a chance to get X-ray pictures.

I was sure that she did not have ureteral stricture causing her symptoms. Her doctor, however, insisted that that was the condition. I suggested that he have an abdominal surgeon see her. He went over her carefully and found some slight mass in the lower abdomen. She was operated on, and a cyst of the ovary with torsion of the pedicle was found. This was removed and she has not had any further attacks of pain supposedly due to stricture of the ureter.

DR. NATHANIEL P. RATHBUN (Brooklyn, N. Y.): In the main I agree with practically all Dr. Paine has said in his excellent paper, with, however, certain reservations. I am perfectly willing to agree that stricture of the ureter in so far as it means a definite fibrosis of the ureter wall occurs very much less frequently than Dr. Hunner and some of the rest of us maintained a few years ago. I do think it occurs fairly com-

monly. I want to maintain, however, that obstructive lesions in and about the ureter do occur very, very frequently.

I rather disagree with Dr. Paine when he implies that those things cannot be relieved by dilatation. I believe that lesions in the male and female pelvis, the broad ligament in the female, the seminal vesicles in the male, very often produce peri-ureteral fibrosis and inflammation, with certain symptoms which can be promptly relieved by dilatation of the ureter. I do not think we can get away from the clinical fact that there are a great many patients who present a series of symptoms which are relieved by dilatation.

I think if we take this thing as a clinical problem rather than as a definite pathological lesion in the ureter wall, we will get a different slant on the matter.

I agree with Dr. Paine and Dr. Hagner that it is perfectly silly to carry on dilatations in the face of other easily recognizable lesions, and I haven't any question but that that has been done a great many times, and done to excess. I still think, as I say, that there are a great many obstructive lesions in and about the lower ureter with a certain train of symptoms that are very easily and readily amenable to dilatation.

Dr. Andrew J. Crowell (Charlotte, N. C.): I heartily agree with Dr. Hagner that it seems impossible to have great pain in the kidney without having some hydronephrosis and ureteral obstruction in some form.

I believe we can find ureteral obstructions, either intrinsic or extrinsic, in practically all cases if a careful search is made for same. To illustrate: I had a patient three or four months ago who came in complaining of frequency and painful urination. A clinician had diagnosed it as stricture of the ureter. The patient's ureters had been dilated about a dozen times without benefit. The ureteropyelogram showed a normal ureter and kidney pelvis, but there were evidences of inflammatory changes in the vertebræ. There was an active lesion in the sacro-iliac synchondrosis at that time. The ureter lay right over this active bone lesion and produced the undue frequent and painful urination.

A plaster cast was put on the patient and the symptoms disappeared. The patient was in my office just a day or two before I left home and reported that he was perfectly com-

fortable, back on his abandoned job, feeling like a different man. We often jump to conclusions and make a "snap-shot" diagnosis without careful investigation.

Dr. William A. Frontz (Baltimore): In our experience, if tuberculosis and those cases of stone of long standing and trauma incidental to instrumental or operative handling be excluded, we have found extremely few cases in which ureteral stricture could not be explained by extra-ureteral factors. It is extremely common to see cases of very long standing infection of the urinary tract with no evidence of stenosis along the ureter, and it is questionable whether these urinary infections *per se* play so important a rôle in the formation of ureteral stricture.

I have been impressed by a number of cases in which seminal vesiculitis proved to be an important factor in the causation of strictures in the lower ureteral segment. The extreme thinness of the vesicular wall and the proximity of the vesicle to the ureter accounts for the not infrequent complication of periureteritis with acute vesiculitis. In this way a number of ureteral stenoses are formed.

In some twelve cases of large hydro-ureter, we have felt that an associated vesiculitis was likely the fundamental factor in the production of the ureteral obstruction.

Dr. John R. Caulk (St. Louis): I wish to report a remarkable complication during the process of treating a multiple carcinomatosis of the bladder. I have seen two cases similar to the case Dr. Lower reported of evident transplantation from the pelvis down to the ureter and the bladder.

This one case was a woman on whom I had removed a tumor of the bladder by local measures, and in preparing to remove the upper tract carcinomatosis she stopped breathing under anesthesia. Her respiration ceased for forty-seven minutes. She was given artificial respiration all that time. Her pulse quit for twenty-two minutes. Dr. Montague Boyd was there at the time. In the meantime we told the family the patient was dead, but after persisting with artificial measures, intracardiac adrenalin, and so forth, the patient began to breathe at the end of forty-seven minutes. She went along quietly and recovered from her anesthesia, only to develop, in several hours, convulsive attacks which lasted three days, and she died. The autopsy

showed practically nothing. Anemia of the brain, of course, we thought would represent certain evidences in the brain, but as a matter of fact nothing was found.

It is the long duration of cessation of breathing and pulse that I wish to report.

DR. GEORGE R. LIVERMORE (Memphis): In discussion of Dr. Paine's paper, I don't see why the report of a few cases of extra-ureteral pressure should damn the diagnosis of obstruction of the ureter from the inside. I can report quite a few cases of similar nature. Every one of you has seen cases in which numerous and multiple operations have been done, the gall bladder has been taken out, the appendix has been removed, the broad ligaments have been interfered with, the uterus has been sutured up, and every other thing done, and still the patient was not relieved because he or she had ureteral stricture.

I agree in the main with what Rathbun has said, that these obstructions do occur, they may be purely inflammatory in type, that stricture of the ureter is a definite entity. Although you may not find any retention in that ureter, if the ureterogram shows some constriction and dilatation of the ureter, or pelvis, or both, it is evidence that there has been some back pressure, and the fact that the patient is relieved by ureteral dilatations certainly is an indication that the relief of the obstruction in the inside of the ureter has been responsible for the relief of the pain.

I have had some cases, too, where a patient had a fibroid of the uterus and the fibroid was compressing the ureter, extra-ureteral pressure, and by sending that patient to the gynecologist and having the fibroid removed, the patient has been absolutely relieved. But that does not prove that obstruction of the ureter does not occur from ureteritis and stricture of the ureter.

DR. HERMAN L. KRETSCHMER (Chicago): Apropos Dr. Paine's paper, when patients come to us with a diagnosis of stricture of the ureter, I feel that we owe it to these patients to send them to a medical doctor and to a gynecologist before instituting treatment. It is my impression that there are a very large number of patients who are being treated routinely for stricture of the ureter that have extra-ureteral pathology. It is a well established fact that patients with chronic prostatitis and chronic seminal vesiculitis may have a stricture of the ureter.

I believe that there are cases of true fibrous stricture of the ureter and I have treated them with dilatation through the cystoscope. Some of these patients I have operated upon, doing a suprapubic cystotomy, cutting the stricture with a scissors and then dilating them with urethral sounds (Van Buren sounds). This group of cases forms a definite clinical entity.

But, on the other hand, it is my impression that many of the patients that are being treated as cases of stricture of the ureter do not have strictures, and I think the reason that many of them are treated for strictures is due to the fact that, as Dr. Paine pointed out, extra-ureteral pathology is overlooked.

Recently I saw a patient who had had fifty ureteral dilatations on her only remaining side. The other kidney was removed because of pain, but the pain persisted after the nephrectomy. Although the patient stated that she had had fifty dilatations and had a stricture, the pyelogram that I obtained was normal. The general physical examination, as well as the urological examination, was negative. It took only about fifteen minutes of interrogation to determine that this woman's pain and her symptoms were but a defense reaction. In other words she had a complex.

Recently I saw a second patient who had had thirty dilatations without relief.

It seems that this is a sort of error that we may be getting into that may be compared, as George Livermore did, to the error of the general surgeons in removing a normal appendix or a gall bladder when the disease is elsewhere.

And finally, I would mention briefly a third patient who had had twenty-five dilatations for stricture and a nephropexy, needless to say, without giving her the desired relief. This patient was referred to the neurological department and her trouble was found to be due to a congenitally weak nervous system plus a disturbance of the thyroid gland. This patient was a real neurological case and not a urological case, and yet this woman was treated for five years for stricture of the ureter.

Dr. Patch's exceedingly interesting case of granuloma of the ureter interested me very much. It was my good fortune, several years ago, to report a case of pyelitis granulosa, associated, as I remember, with an infection due to the colon bacillus. It is my impression, somehow or another, that these cases are due

in a good many instances to infection, and the patient may come to us after the infection has subsided. This rare condition, as you know, occurs not only in the kidney pelvis but also in the ureter and in the bladder where the cases have been described under the name of cystitis follicularis and as cases of pseudocystitis.

This condition not only occurs as an entity, but I recall a case that I reported some years ago on Dr. L. E. Schmidt's service at the Alexian Brothers Hospital, in which the patient had, besides a cystitis follicularis, a cystitis cystica. Dr. Schmidt did a suprapubic cystotomy for drainage. Pieces were removed for histological study. Cystoscopy was performed a year later, the bladder was normal and the lesions had completely disappeared.

This brings up the interesting question concerning the origin of lymph tissue, whether it is due to tissue reaction due to infection, or whether lymph tissue is present in the bladder normally. There is still some doubt in the minds of some anatomists whether or not lymph tissue normally occurs in the bladder.

Dr. Harry A. Fowler (Washington): Time did not permit the reading of the entire paper in which the question of differential diagnosis between papillary growths in the pelvis and the bladder was taken up. Dr. Braasch, however, in his discussion, has pointed out the importance and the difficulty of differential diagnosis.

Gottlieb has divided these cases from the standpoint of diagnosis into three groups: those in which a papillary growth protrudes from the ureteral orifice, making the diagnosis simple; second, those in which a previous nephrectomy has been done for a papillary tumor of the kidney pelvis, in which case this source of the bleeding has been ruled out; and there is left the third and most difficult group—the group in which a preoperative diagnosis is seldom made. It comprises those cases in which the tumor of the ureter is well above the vesical orifice and may or may not be associated with a vesical growth.

As to the point whether the ureteral tumor preceded the vesical growth, it is unfortunate that we cannot absolutely say, because no investigation of the ureter or kidney was made. The fact, however, that the patient had a hematuria over a period of twenty-five years and that no pathology was suspected in the

kidney during a period of eight years during which the patient was under observation, leads us to believe that probably here we have an independent growth rather than metastasis from the ureter.

DR. GILBERT J. THOMAS (Minneapolis): Just a word about Dr. Fowler's paper. Some years ago, as he mentioned in his paper, we reported quite a number of cases of papilloma of the pelvis, of the ureter, and of the bladder.

In the first case we saw following that report we missed the diagnosis. As far as we know there was a papilloma originating in the ureter. We were unable to demonstrate a lesion in the pelvis of the kidney; we could not see one in the bladder. The patient had no severe renal colic, but an ache in one side which was unexplained. There was no shadow on the roentgenogram. The urogram revealed a small or very moderate dilatation of the pelvis, and the same moderate dilatation of the ureter, which extended to the bladder. Because we could not find a lesion, we thought that there might be some inflammatory obstruction at the meatus, and we used bulbs to dilate. In retracting the bulb into the bladder one time, I pulled out a small bit of tissue which looked like a feather. I filtered the urine through gauze as it came out of the bladder, and obtained this little feather. I had it examined by the pathologist, who reported papilloma. We immediately made an examination to see if we could feel anything in the lower ureter, re-checked our pyelogram, and still missed a papilloma in the lower end of the ureter, which did not protrude into the bladder.

Except for the rarity of the condition, I think the point is one we must remember when we have papilloma of the pelvis of the kidney or of the bladder. The same condition may originate in the ureter and the diagnosis may be very difficult

TRANSPLANTATION OF THE URETERS TO THE SIGMOID

AN EXPERIMENTAL STUDY IN DOGS

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Believing that the development and execution of a surgical procedure must have a clear and well understood physiological and pathological background, we have undertaken this animal experimentation. The surgical technic of ureteral transplantation has made rapid progress since 1909, but for obvious reasons there has not been a corresponding progress in the end-results of such cases. Over-enthusiasm can do irreparable damage to any new surgical procedure unless the limitations and possible remote changes in the organism are well understood. A study of the current literature suggests that we are approaching such a state in transplantation of the ureters into the large bowel. We believe that the technics variously advocated are not sufficiently stabilized for the operation to be regarded lightly.

The battlefront of investigation has been far-flung, but the privilege of employing this operation in a number of human patients has fallen to only a few men. For that reason reported efforts of isolated investigators on a small scale will aid in completing the final picture.

An extensive review of the literature would be futile at this time. Only those articles which are pertinent to the purpose of this paper are included for discussion. The development of Coffey's technic is the most significant factor on this subject in the American literature. His three major contributions were: (1) the mucous membrane valve, which adequately prevents regurgitation of fecal material up the ureter; (2) the use of tubes to prevent postoperative occlusion of the ureters; (3) the extensive cleansing of the lower bowel to insure a relatively sterile operative field.

In 1929 he reported twenty cases in which this technic had

been used. Autopsies were done on three of the five patients who died. Two of the three, Cases 7 and 8, had extensive carcinomas of the bladder and died seventy-five days and 290 days after operation. Microscopic examination of the kidneys showed a mild leukocytic infiltration and parenchymatous degeneration. One, Case 20, died six days after operation and the pathologist found normal kidneys. From his own personal experience he believes that both the problem and the technic have been solved and that the operation may be safely recommended to skilled surgeons.

To C. H. Mayo belongs the credit for the widest clinical experience with ureteral transplantation. In 1924 he reported a series of thirty-five cases. Both ureters were transplanted in twenty-eight patients; one died of peritonitis and twenty-three patients have been followed. Five complain of lumbar pain at times; otherwise there are no complaints. Mayo's technic differs from the completed Coffey technic in that (1) he does the operation in two stages; (2) he does not use tubes; (3) he does not clean the lower bowel so extensively. The one step common to both is the mucous membrane valve, yet their results are quite parallel.

After noting the two above procedures and results, a study of Turner's review of seventeen personal cases is interesting if not confusing. He used neither the Coffey nor Mayo technics but that of Stiles, which does not form a mucous membrane valve. There were four deaths, three from peritonitis and one due to septic dermatitis. There are ten patients living and well from seven months to fifteen years after operation. The report is particularly valuable because of the full follow-up notes on the living and the autopsy records of the dead. One died three years after operation from intestinal obstruction, and one died two years after operation from a plastic operation on the bladder. Their progress up to the time of death did not indicate renal infection, but autopsy revealed a pyonephrosis in one case and a hydronephrosis with dilated ureter in the other case.

He particularly urges that as much of the blood supply to the ureters as possible be saved and in his operation he stresses: (1) two-stage operation; (2) Mayo catgut urine guide; (3) drain tube from area of anastomosis. He has also observed the frequency of attacks of renal infection soon after the operation,

from which the patient readily recovers, and he believes that moderate renal infection is not inconsistent with average good health. The more than casual relationship of an impeded opening into the bowel to infection has also been recognized by Turner. He could not force water up the ureters in his autopsy specimens.

The three foregoing clinical reports, although the cream of the current literature, offer little aid in studying the pathology and physiology of transplanted ureters. To depend upon the human subject for this information means many years of waiting, and then the reported cases will be few and scattered. Obviously, then, animals offer a solution, and to McKenna belongs the credit for studying end-results over a period of time. His was the first work in which dogs lived for more than a year with a transplanted ureter. The successful results which he published prompted us to apply this investigation with a broader purpose. He transplanted one ureter by the Coffey technic, and three dogs were allowed to live fourteen months and one dog twenty-four months. He studied the function and bacteriology. In every case the function was normal in the transplanted kidney, and cultures from both sides were sterile. Our experience with the operation in dogs has not been as satisfactory as McKenna's, and we believe it will show that the last word has not been said concerning renal infection.

Female dogs were used in this work because the external male genitalia interfere both with the surgical exposure and the cleanliness of the operative field. On the whole, dogs are well adapted for this type of investigation. They do not withstand infection very well, however, because of poor general resistance and the highly virulent bacteria present in the normal intestinal flora. The only technical difficulty arises from the thick and rigid muscular coat of the bowel wall, which makes closure of the anastomosis more difficult and less secure than in the human. We believe that our results demonstrated that in these animals the operative technic may be executed with relative ease and that peritonitis arising from soiling by the opening of the bowel, even though no drainage is used, is not a serious factor. In only one animal did we feel that peritonitis was caused by soiling at the time of the operation. Two other animals developed peritonitis; in one it resulted from a severe wound infection and in

the other from evisceration in a pregnant dog in which operation was attempted too near term.

This study is composed of thirty-one operations performed on twenty-nine dogs. One of the purposes of the work was to compare the end-results of ureteral transplantation, using the technics as described by Mayo and Coffey in the individual reports of their work. The operative technics have been so fully described elsewhere that no details need be given here. In every case we used the submucous implantation as originally developed by Coffey. In one group of cases we followed the operative technic as described by Mayo, allowing for single transplantation, and in the second major group we followed the recent technic of Coffey, permitting bilateral transplantation by using ureteral catheters as well as the cleansing of the lower bowel. Hence, we shall hereafter refer to one as the Mayo technic, in which no ureteral catheters were used, and designate as the Coffey operation those cases which followed the operative technic described in his later publication.

MAYO TECHNIC—ONE URETER TRANSPLANTED

In seven animals, Numbers 1, 4, 5, 6, 7, 8, and 11, a single ureter was transplanted by the Mayo technic. Dog Number 1 was killed on the seventh day because of complete evisceration of the abdominal contents. Two died on the fifty-sixth and ninety-fourth days, and for various reasons the others were killed on the thirty-second, fifty-sixth, sixty-eighth, and one hundred nineteenth days. The complete records of these dogs follow:

Dog No. 1.—The right ureter was transplanted into the sigmoid June 6, 1929. The dog was killed seven days later because of complete evisceration. The autopsy showed a small amount of pus in the right perirenal area. Neither the ureter nor the pelvis of the right kidney was dilated. The area of the anastomosis was well healed and showed no evidence of leakage. The right kidney, ureter, and the sigmoid were removed intact. On opening the sigmoid, no ureteral opening could be demonstrated, and a fine probe passed down the ureter presented beneath the mucosa, which was smooth in this area. No microscopic sections were obtained.

Dog No. 4.—The right ureter was transplanted into the sigmoid July 7, 1929. The dog recovered without incident but contracted mange so badly that it was necessary to kill her November 25,

one hundred and nineteen days after operation. The peritoneum was smooth and glistening throughout. There were a few adhesions in the region of the anastomosis. The right kidney, ureter, and the sigmoid were removed intact. The pelvis and ureter were not dilated, but the kidney was one-third as large as the left. The area of the anastomosis was perfectly healed. On gross section there was much fibrosis in the cortical area of the right kidney. A No. 4 pointed ureteral catheter, passed down the ureter, entered the sigmoid without obstruction. The left kidney appeared entirely normal. There was no gross evidence of pus anywhere in the urinary tract. Non-protein nitrogen taken before death was 35 milligrams.

Microscopic sections of the right kidney showed a diffuse cellular infiltration, with marked fibrosis throughout. Sections of the left kidney showed extensive cloudy swelling of the tubules and glomeruli but no evidence of pyogenic infection.

Dog No. 5.—The right ureter was transplanted August 2, 1929. Due to the fact that the dog contracted distemper and was losing weight rapidly, she was anesthetized September 9, thirty-two days after operation, in order to have a comparison of the two kidneys before death. There were no adhesions in the abdomen, and the anastomosis was perfectly healed. The right kidney was twice the size of the left; it was dark in color and showed many dilated veins over the surface. The right ureter was dilated to the size of a lead pencil. An opening was made in each ureter and catheters introduced. About 75 c.c. of cloudy urine, which showed pus IV was immediately obtained from the right kidney. Urine from the left kidney showed an occasional pus cell. Both right and left sides showed bacillus coli on culture. Functional test was unsatisfactory because of small amount of urine obtained.

The dog was killed with chloroform and the right kidney, ureter, and sigmoid were removed intact. The left kidney was also removed. A No. 4 ureteral catheter could not be passed down the ureter into the sigmoid, as the opening in the mucous membrane had healed completely. The mucous membrane in the area over the end of the catheter showed no rugæ.

Microscopic section of the right kidney showed an inflammatory reaction throughout the pelvis and cortex, with cellular infiltration. Some areas of the cortex contained small abscesses. Sections of the left kidney showed only cloudy swelling.

Dog No. 6.—The right ureter was transplanted August 7, 1929. The dog recovered from the operation without incident and from then on never appeared to be sick and seemed well the day before death, November 9, ninety-four days after operation.

At autopsy the operative wound was healed. The peritoneum was smooth and glistening, and there was no fluid in the abdomen. The

anastomosis was in good condition. The right kidney was very small, about one-half the size of the left. The right ureter was slightly larger than the left, and the right pelvis was slightly dilated. The right kidney, ureter, and sigmoid were removed intact. The left kidney and a portion of the left ureter were also removed. The wall of the sigmoid was quite thin and no rugæ were present. A small ureteral catheter passed down the ureter would not enter the sigmoid because the opening had been closed by mucous membrane of the bowel. There was no gross evidence of pus in either kidney.

Microscopic study of the right kidney showed the changes of acute inflammation, with cellular infiltration throughout. The left kidney showed only cloudy swelling.

Dog No. 7.—The right ureter was transplanted August 13, 1929. The dog recovered nicely from the operation and was quite active for a month. She then began to refuse her food and looked sick. This downward course was progressive, and she died October 8, fifty-six days after operation.

At autopsy the operative scar was well healed. The abdomen was markedly distended. On opening the peritoneum, which was flaming red, a large amount of blood-tinged pus was seen to fill the entire abdomen. The right kidney was three times the size of the left. The upper pole was soft and necrotic, and fluid was seen to ooze out. The ureter was dilated about three times normal size. The right kidney, ureter, and a portion of the sigmoid were removed intact. The kidney was opened and found to be a mere shell. The cortex was perforated at the upper pole. A No. 6 catheter passed into the sigmoid without obstruction.

Microscopic study of the right kidney showed a dense infiltration, with polymorphonuclear leukocytes throughout the whole organ. In one area a large blood clot was seen. Scattered areas of fibrous tissue formation were seen in the cortex. The left kidney showed a diffuse cloudy swelling.

Dog No. 8.—The right ureter was transplanted August 19, 1929. In this operation the catgut urine guide was not used. The dog progressed well for one month and then began to lose weight and strength. On October 14, fifty-six days after operation, she was anesthetized in order to study the function of the kidneys and to obtain urine cultures. The previous operative scar was well healed, and the peritoneum was normal. There were many adhesions in the area of the ureteral anastomosis. Both kidneys were normal in size and color. The right ureter was dilated to the size of a lead pencil. The preters were opened and catheters tied in. Thick pus was obtained from the right side, but urine from the left kidney showed a very occasional pus cell. Cultures from both sides showed bacillus coli. A functional test was done. The dye appeared on

the left side in three minutes in concentration IV, but no dye appeared on the right side in thirty minutes.

The dog was then killed with chloroform and the right kidney, ureter and sigmoid removed intact. The right kidney consisted of practically a mere shell of tissue. A small ureteral catheter passed down the ureter met obstruction just beneath the mucosa of the sigmoid and no opening could be demonstrated.

Microscopic sections of the right kidney showed a dense infiltration of leukocytes in the submucosa and mucosa of the pelvis. There were multiple abscesses in the cortex. The left kidney showed a lymphocytic invasion of the submucosa of the pelvis. There was no evidence of pyogenic infection elsewhere. There was a diffuse cloudy swelling.

Dog No. 11.—The right ureter was transplanted September 18, 1929. The postoperative progress was uneventful for one month, and then the dog contracted mange, which caused her to become quite weak and emaciated.

An attempt was made to anesthetize the animal November 25, sixty-eight days after operation, but she died before urine specimens could be obtained. The peritoneum was normal, and there were no adhesions in the abdomen. The right kidney was one-half the size of the left, and the right ureter was twice the size of the left. The pelvis of the kidney was not dilated and the lining was smooth and glistening. The right kidney and ureter were removed with the sigmoid. The right ureter was patent throughout except at the opening into the sigmoid, which was closed over by the mucous membrane of the bowel.

Microscopic sections of the right kidney showed a dense invasion of the submucosa of the pelvis with polymorphonuclear leukocytes and lymphocytes. There were no cellular products of inflammation in the cortex, which showed an extensive cloudy swelling. The left kidney showed no evidence of pyogenic infection but did show a marked cloudy swelling.

Although the Mayo catgut urine guide was used in all the above cases except Number 8, the ureteral opening was closed by bowel mucosa in five of the seven cases. It will be noted that this closure of the uretero-sigmoidal opening occurred even in Number 1, which was killed on the seventh postoperative day.

In one (Number 7) the ureter was patent throughout, but the animal died from rupture of a pyonephrosis on the side of the transplanted ureter. The best result in the group seemed to be Number 4, in which there was no gross evidence of infection but the kidney was quite small as compared with the unoperated side. Microscopic examination of this kidney, however, showed

marked fibrosis, cellular infiltration, and destruction of the glomeruli by fibrous tissue.

In only two cases in this group (Numbers 5 and 8) were cultures taken from both kidneys just before death, and in each case the cultures showed a bacillus coli infection in the untransplanted as well as the transplanted side.

We did not obtain a satisfactory result in a single case in this group, the failure being attributed to closure of the uretero-sigmoidal opening and to renal infection.

MAYO TECHNIC—BOTH URETERS TRANSPLANTED

In three animals both ureters were transplanted by the Mayo technic. Both ureters were transplanted at one operation in Number 26, and death occurred on the third day, apparently from uremia. No autopsy was done. In Number 2 the left ureter was transplanted sixteen days after the right. Death occurred six days after the second operation, due to a localized peritonitis resulting from soiling at the time of the second operation. In Number 3 the left ureter was transplanted seventy days after the right and death occurred fifty-three days later. Both ureters were open but stenosed, and cultures showed streptococci on the right and bacillus coli on the left. The complete reports of Numbers 2 and 3 follow:

Dog No. 2.—The right ureter was transplanted July 3, 1929. Recovery was uneventful and sixteen days later the left ureter was transplanted. The dog never appeared well after the second opration and died July 25, six days after the second operation.

At autopsy the operative wound was not healed. A localized area of pus was found in the left lower quadrant. No pus and no signs of infection were found elsewhere in the abdominal cavity. The ureters and kidneys appeared normal in size. The right anastomosis was well healed, and the left showed some soft adhesions but no signs of urinary leakage. Both kidneys, both ureters, and the sigmoid were removed. The pelves and ureters were not dilated and showed no gross pus. A No. 5 ureteral catheter would not pass through the uretero-sigmoidal openings, which were pin-point in size.

Microscopic sections of the right kidney showed a marked inflammatory reaction, with cellular infiltration throughout the organ. The left kidney showed a mild inflammatory infiltration in the mucosa of the pelvis and a marked destruction of the tubules and glomeruli by cloudy swelling.

Dog No. 3.—The right ureter was transplanted July 22, 1929. The dog seemed quite well and seventy days later the left ureter was transplanted. For about six weeks she was active but then began gradually to become weaker and refused to eat. She was anesthetized fifty-three days after the second operation in order to obtain urine cultures before death. The peritoneum was smooth and glistening. Both kidneys were enormously enlarged and both ureters were dilated and kinked. The anastomosis appeared normal. Ureteral catheters were tied in the ureters and cultures obtained, which showed streptococci on the right side and bacillus coli on the left side. Both sides showed much pus. The dog was killed and both kidneys and ureters were removed with the sigmoid. The uretero-sigmoidal openings were patent but markedly stenosed.

Microscopic sections of the right kidney showed an extensive inflammatory reaction throughout the pelvis and cortex. The left kidney showed no cellular infiltration, but there was a marked congestion with hemorrhage and an extensive destruction of the tubular epithelium by cloudy swelling.

The results in the above two cases were obviously poor. Marked infection occurred in all four kidneys as was demonstrated by the microscopic sections. The pathological picture is essentially the same as was seen in the unilateral Mayo transplants.

COFFEY TECHNIC—BOTH URETERS TRANSPLANTED

In eight animals, Numbers 9, 10, 12, 13, 14, 21, 22, and 24, both ureters were transplanted at the same time by the Coffey tube technic. They lived from seven to thirty-one days. The complete records of these eight dogs follow:

Dog No. 9.—Both ureters were transplanted September 6, 1929. Following the operation the dog was quite sick for a few days, and the ends of the catheters had to be cut frequently to keep them draining. The first catheter came out on the ninth and the second came away on the tenth postoperative day. The stools were liquid from that time on. During the next week the dog appeared quite normal. She then began to lose weight quite rapidly and continued to marked emaciation. On October 6, thirty days after operation, the animal's condition was very poor, so anesthesia was started in order to do functional tests and obtain urine cultures, but she died before the abdomen was opened.

At autopsy the peritoneum was smooth and glistening. There were a few adhesions in the lower abdomen. The right kidney appeared to be slightly enlarged, and the right ureter was larger than normal. The left kidney was three times the size of the right. There were many engorged vessels over its surface. On gross section this kidney showed a large hydronephrosis, the renal paren-

chyma being reduced to a mere shell, in which the normal markings were obscured. The left ureter was also about three times as large as the right and showed a kink in the lower third. Catheters passed down both ureters entered the sigmoid without obstruction.

Microscopic sections of the right kidney showed an extensive edema throughout, with destruction of the tubular epithelium. There were many small cysts formed by rupture of the tubules. There were no cellular products of inflammation. The left kidney showed many small cysts in the cortex, and the blood vessels were dilated and full of blood. There was an extensive cloudy swelling. There was no evidence of pyogenic infection.

Dog No. 10.—Both ureters were transplanted September 16, 1929, and five days later both catheters came out. Up until this time and for twenty-four hours afterward the dog appeared well, and the stools were liquid. On September 22, the dog appeared quite sick, and there was a purulent exudate from both eyes. Death occurred on the afternoon of September 23, seven days after operation.

At autopsy the operative wound was not healed. There was free fluid in the abdomen and much pus in the pelvis as well as along the course of the left ureter. The ureters were not dilated. The right kidney was about twice the normal size and showed a reddish color. The left kidney was normal in size and color. The left anastomosis showed a partial separation from the sigmoid but the right was in good condition. Catheters passed down both ureters entered the sigmoid without obstruction.

Microscopic section of the right kidney showed complete destruction of kidney tissue throughout, with multiple abscesses. The left kidney showed no evidence of pyogenic infection, but there was a marked destruction of the tubular epithelium and the glomeruli by cloudy swelling.

Dog No. 12.—Both ureters were transplanted September 19, 1929. At the time of operation it was noted that the dog was pregnant. Two days after operation the catheters came away. The condition of the dog seemed good and the stools were liquid. On September 25 the operative wound broke open and a small knuckle of gut protruded. Within a few minutes the dog was anesthetized and a secondary closure of the abdominal wound was done. The dog died seven days after operation.

At autopsy there was a large amount of free pus in the abdomen. The intestines were matted together. The right kidney was slightly larger than normal, and the left was normal in size. The ureters were not dilated. The kidneys and ureters were removed with the sigmoid attached. The kidneys showed some congestion but no macroscopic pus. The anastomoses were healed. Catheters passed down both ureters entered the bowel without obstruction.

Microscopic section of the right kidney showed an inflammatory reaction, with a lymphocytic infiltration beneath the mucosa of the pelvis. The remainder of the kidney showed destruction by cloudy swelling. The left kidney showed characteristic cloudy swelling. The blood vessels were dilated and full of blood. There were no evidences of pyogenic infection.

Dog No. 13.—Both ureters were transplanted October 9, 1929. The non-protein nitrogen taken at the time of operation was 35 milligrams. Urine cultures from both sides were sterile. Following operation the dog failed to eat and showed a progressive downward course. Catheters came away on the third and fourth postoperative days. On the fourteenth postoperative day the non-protein nitrogen was 138 milligrams and on the twenty-first postoperative day the non-protein nitrogen was 113 milligrams. Death occurred on the thirty-first postoperative day.

At autopsy the operative wound was well healed. The peritoneum was smooth and glistening. The right kidney and ureter were normal in size. The left kidney and ureter were slightly dilated. The left ureter showed two kinks due to adhesions. Both anastomoses showed that the sutures in the muscularis had pulled out so that the mucosa of the sigmoid was exposed and no valve action obtained. Catheters passed down both ureters entered the bowel, but there was a slight stenosis of the left uretero-sigmoidal opening. On gross section both kidneys were seen to contain pus.

Microscopic sections showed small abscesses throughout the cortex. In several areas the capsular spaces showed an accumulation of albuminous material. The left kidney appeared as did the right.

Dog No. 14.—Both ureters were transplanted October 11, 1929. Following operation the dog showed a progressive downward course. One catheter came away in twelve hours, and the second catheter came away after two days. Eighteen days postoperative the non-protein nitrogen was 146 milligrams. Death occurred October 30, nineteen days after operation, at which time the dog was markedly emaciated and showed a bilateral purulent conjunctivitis.

At autopsy the peritoneum was smooth and glistening. There was a few adhesions around the urinary bladder. Both anastomoses were well healed, and the left kidney and ureter were normal in size. The right kidney was somewhat smaller, and the right ureter was not dilated. A catheter passed down the left ureter entered the sigmoid without obstruction. A catheter passed down the right ureter would not enter the sigmoid, as the uretero-sigmoidal opening was covered over by mucosa of the bowel.

Microscopic sections of the right kidney showed a diffuse acute inflammatory reaction in the cortex. There were many small abscesses in the mucosa and submucosa of the pelvis. The left

kidney showed only one area in which there was an inflammatory reaction, and this was around a fibrous glomerulus.

Dog No. 21.—Both ureters were transplanted December 2, 1929. After operation the dog showed a progressive downward course. Both catheters came out on the twelfth day, and death occurred on the seventeenth postoperative day.

At autopsy a small superficial abscess was found in the operative wound. The peritoneum, however, was smooth and glistening. The right kidney was somewhat smaller than the left, and the lower pole showed an area of dark discoloration. The ureter was not dilated. On gross section free pus was found in the pelvis, but the cortical and medullary markings were normal. There were infarcts in the upper and lower poles. The right anastomosis was normal, and a catheter passed down the ureter entered the bowel without obstruction. The left kidney was slightly larger than the right, and the pelvis contained frank pus. The cortical and medullary markings were distinct, and the pelvis was not dilated. The left ureter was normal in size and patent throughout. The left anastomosis was well healed.

Microscopic sections of the right kidney showed no evidence of pyogenic infection. The left kidney showed a cellular infiltration beneath the mucosa of the pelvis and polymorphonuclear leukocytes were seen scattered through the cortex. Some of the glomeruli were replaced by fibrous tissue. Both kidneys showed marked evidence of cloudy swelling.

Dog No. 22.—Both ureters were transplanted December 9, 1929. The postoperative non-protein nitrogen was 40 milligrams, and cultures of the urine taken at the time of operation were sterile. Both catheters came out on the fifth day. The dog showed a progressive downward course after operation. Shortly before death the non-protein nitrogen was 98 milligrams. The dog was killed on the tenth postoperative day because of poor general condition.

At autopsy the operative wound was slightly infected. The peritoneum, however, was smooth and glistening, and there were no adhesions in the abdomen. The right kidney was about three times normal size and quite dark in color. The right ureter was also dilated. The left kidney and ureter were slightly larger than normal. On gross section the parenchyma of the right kidney was soft and hemorrhagic throughout, and the cortical and medullary markings were obliterated. The pelvis was dilated and full of pus. The right anastomosis was well healed, and a catheter passed down the ureter entered the bowel without obstruction. On gross section the left kidney showed normal markings, and the pelvis was not dilated but contained frank pus. The left anastomosis was well healed. A catheter passed down the left ureter entered the bowel

without obstruction. The intra-sigmoidal portion of the left ureter had not sloughed off.

Microscopic sections of the right kidney showed a diffuse cellular infiltration, with abscess formation in the cortex. The left kidney showed a generalized inflammatory reaction but no abscesses.

Dog No. 24.—Both ureters were transplanted December 16, 1929. Following operation the dog showed marked loss of weight and refused to eat. Both catheters came away on the fifth day. Urine cultures taken at the time of operation were sterile, and the non-protein nitrogen was 27 milligrams. The animal died ten days after operation.

At autopsy the operative wound showed a small abscess. The peritoneum, however, was smooth and glistening. There were no adhesions in the abdomen. The left kidney was enlarged about three times normal size and was soft and fluctuant. On section, a large amount of turbid urine escaped, and the pelvis seemed to be markedly dilated. The cortex of the left kidney was quite thin, but the markings were distinct. The left ureter was correspondingly dilated. The right kidney was enlarged about twice the normal size and, on section, was found to contain a large amount of yellowish purulent material. The cortical markings were indistinct, and the pelvis was dilated and showed an exudate on its surface. The right anastomosis was well healed. The left anastomosis showed infection in the lower portion. Both uretero-sigmoidal openings were stenosed, so that No. 6 catheters were passed with difficulty.

Microscopic sections of both kidneys showed extensive infection throughout. There was much hemorrhage and a few infarcts were found beneath the capsule.

In four dogs, of the above group, Numbers 13, 14, 22, and 24, we were able to demonstrate histological evidence of bilateral renal infection. Three dogs, Numbers 10, 12, and 21, showed infection in only one side, and in one animal, Number 9, we were unable to find microscopic evidence of pyogenic infection. Number 9, however, showed a large hydronephrosis with parenchymal destruction.

Complete closure of the uretero-sigmoidal opening occurred in only one ureter, Number 14, and in this animal one catheter was pulled out a few hours after operation. The two cases, Numbers 13 and 24, in which the ureteral openings were stenosed, showed an extensive infection in both kidneys. A completely normal kidney was not seen in the entire group, although

five kidneys failed to show microscopic evidence of pyogenic infection.

COFFEY TECHNIC—ONE URETER TRANSPLANTED

In two dogs, Numbers 15 and 16, a single ureter was transplanted by the Coffey technic. The results in these two operations were better than we had obtained in any of the groups thus far studied. The dogs lived for seventy-six and eighty-seven days, and at autopsy there was no macroscopic evidence of disease in the urinary tract. Microscopic study showed no evidence of pyogenic infection. Apparently these were successful transplants, but the dogs did not appear well after being operated on.

Dog No. 15.—The right ureter was transplanted October 30, 1929. The catheter came out on the second day. The dog refused to eat for two weeks before death. She had appeared well up until that time except for loss of weight. Death occurred January 14, 1930, seventy-six days after operation.

At autopsy the peritoneum was smooth and glistening. There were a few adhesions around the bladder. Both kidneys were of the same size and color. On gross section the right kidney showed no evidence of infection. The right ureter was of normal size, and a catheter, passed down the ureter, entered the bowel without obstruction. The anastomosis was in good condition.

On microscopic section there was no inflammatory reaction in either kidney. Both kidneys showed some cloudy swelling.

Dog No. 16.—The right ureter was transplanted November 6, 1929. The catheter came out on the thirteenth day. The animal never appeared quite normal after the operation and steadily lost weight. About one month after operation she contracted mange, for which she had to be killed February 5, 1930, eighty-seven days after operation.

Ether anesthetic was started, but the dog promptly died. There were no signs of peritonitis. The kidneys were of equal size and color. The transplanted ureter was not dilated, and a catheter, passed down it, entered the bowel without obstruction. The anastomosis was in excellent condition. On gross section there was practically no difference between the transplanted and the untransplanted sides.

On microscopic section there was no inflammatory reaction in either kidney. Both kidneys showed some cloudy swelling.

In comparing the results of the Mayo and Coffey operations in dogs, some difference is noted in so far as infection is con-

cerned. The microscopic sections of the kidneys operated by the Coffey technic showed less evidence of pyogenic infection, but the dogs were all definitely sick after transplantation was done. Obviously the best results were obtained by the Coffey technic, in which only one ureter was transplanted. The troublesome ureteral stenosis so often mentioned by workers in this field seems to be largely obviated by the use of the ureteral catheters.

The high incidence of postoperative renal infections led to considerable speculation as to the manner in which the kidney becomes involved. Close observation of a recent clinical case suggested to us that infection may reach the kidney by means other than the lumen of the ureter. The following is a short summary of the progress of this case:

A boy, aged ten, was admitted to the hospital November 7, 1929, with exstrophy of the urinary bladder. Preoperative studies showed an uninfected urinary tract and the non-protein nitrogen was 35.6 milligrams. He was operated on December 3, 1929, and both ureters were implanted in the sigmoid by the Coffey tube technic. No. 8 ureteral catheters were used and urine drained well during and after the operation. The ends of the catheters were placed in sterile bottles covered with sterile corks. Each time the bottles were emptied, fresh sterile bottles were used. The immediate postoperative convalescence was uneventful except for marked abdominal distention, which was finally relieved by irrigation through a rectal tube. Four days after operation urine from the right and left catheters showed one to three pus cells per field. Seven days after operation urine from the right catheter showed one to three pus cells per field, and urine from the left catheter showed fifteen to thirty pus cells per field. Nine days after operation the right side showed five to ten pus cells per field and the left twenty to forty. Eleven days after operation both sides showed pus cells too numerous to count, and culture of the urine showed streptococci and bacillus coli. The left catheter came out eleven days and the right catheter came out seventeen days after operation. Shortly before the catheters came away the non-protein nitrogen was 33 milligrams, and three days after the last catheter came out the non-protein nitrogen was 65.6. Three days later it had dropped to 34 milligrams. About forty-eight hours after the second catheter came away, the patient developed a sharp rise in temperature, which reached 105 degrees. At the same time localized tenderness was noted in the left costovertebral angle, which persisted for several days. After four days the temperature returned to normal and remained there. The patient's recovery was delayed by a low-grade

wound infection. He was discharged January 26, 1930, at which time he could retain his urine for as long as six hours. His general condition was excellent and a letter from his mother, April 10, 1930, says that he is now enjoying excellent health. He is to return in a few months for removal of the bladder.

The beginning and the progressive increase of the infection while the catheters were in place and amply protected, we believe, offers a strong argument against renal infection ascending up the lumen of the ureter in this case.

TRANSPLANTATION OF LIGATED URETERS

In an attempt to study the question of renal infection, four groups of experiments were done on eight dogs.

The right ureters were doubly ligated with linen in the first group, dogs Numbers 17 and 18, and the ureters transplanted by the Mayo technic. Urine collected from the right kidneys at the time of operation was sterile. The complete records of the two dogs in group one follow:

Dog No. 17.—Operation was performed November 8, 1929, and the dog was anesthetized for study seven days later. There was no peritonitis but a few adhesions were found in the region of the anastomosis. The right ureter was dilated to about three times the normal size. On pulling aside the gut, a large amount of free pus was found in the right perirenal area. Culture of this pus showed streptococci. The left kidney and ureter appeared normal. Urine from the right kidney showed bacillus coli and many pus cells. The dog was then killed with chloroform, and the upper pole of the right kidney was found to be adherent to the liver. The right kidney was three times the size of the left, was dark in color, and showed a large number of engorged vessels over the surface. On gross section the left kidney appeared entirely normal. On gross section the right kidney showed a marked thickening of both the cortex and medulla, with a loss of all normal markings. At the lower pole was a subcortical abscess of about 4 cm. in diameter, and in the upper pole there was another subcortical abscess about 2 cm. in diameter. A No. 4 catheter, passed down the right ureter, entered the sigmoid without obstruction.

Microscopic sections of the right kidney showed an extensive inflammatory exudate throughout the substance of the kidney. The left kidney showed the changes of cloudy swelling. There was no evidence of pyogenic infection.

Dog No. 18.—Operation was performed November 22, 1929, and the dog was anesthetized for study three days later. There was

a localized abscess at the site of the previous incision. The pelvic peritoneum was inflamed, and there was a suppurative process at the site of the anastomosis with many adhesions in this area. Urine taken from the right kidney showed bacillus coli. The dog was then killed with chloroform. The right kidney was slightly larger than the left, but the ureter was normal in size. The left kidney appeared entirely normal. A catheter, passed down the right ureter, did not enter the sigmoid, as the ureter was still firmly ligated. The sutures at the site of anastomosis had sloughed out and free pus was found in this area. On gross section the right kidney showed a reddish discoloration of the medulla and cortex, although the parenchymal markings were distinct. There was a slight hydronephrosis, and the pelvis contained macroscopic pus.

Microscopic sections of the right kidney showed an acute inflammatory reaction in the pelvis, with abscess formation beneath the mucosa. The left kidney showed no evidence of pyogenic infection.

Right renal infection was demonstrated in both dogs of the above group. In one, Number 17, the ureter was patent and no opinion can be given as to the manner in which the kidney became infected. In Number 18, however, the ureter was still firmly ligated, which would indicate that the lumen of the ureter could not have transmitted the infection.

In the second group, dogs Numbers 19 and 20 of these experimental operations, we made an effort to protect the end of the ureter. In this group the right ureter was doubly ligated with linen and a small opening was made in the mucosa as for a transplant so that the end of the ureter was potentially infected. This opening in the mucosa was then closed with fine catgut and the ureter implanted between the mucosal and muscular layers of the sigmoid. Urine from the right kidney was sterile in each case. The complete records of the two dogs in group two follow:

Dog No. 19.—Operation was performed November 25, 1929, and the dog was anesthetized for study eight days later. The operative wound showed a low-grade infection, but the peritoneum was normal. There were a few adhesions in the region of the anastomosis. Culture obtained from the right kidney showed diphtheroid bacillus. The right kidney was slightly larger than the left and showed many engorged vessels over its surface. The right ureter did not appear dilated. On cut section the right kidney showed normal markings, but the pelvis was slightly dilated. There was no gross evidence of infection. A No. 4 cathe-

ter, passed down tthe right ureter, entered the bowel without obstruction.

Microscopic sections of the right and left kidneys showed no evidence of pyogenic infection. There was some destruction in the tubular epithelium due to cloudy swelling.

Dog No. 20.—Operation was performed November 29, 1929, and the dog was anesthetized for study eight days later. There was a low-grade wound infection. The abdominal cavity was clean. There was a mass of adhesions in the lower abdomen in the area of anastomosis. Urine obtained from the right kidney for culture showed bacillus coli and streptococci. The right kidney was normal in size but was soft and fluctuant throughout. On gross section the right kidney showed clear urine in the pelvis, which was not dilated. The parenchyma was normal in color and thickness. The markings were distinct. The ureter was of uniform thickness and not dilated. A catheter passed down the right ureter entered the bowel without obstruction.

Microscopic sections of the right kidney showed small areas of cellular infiltration beneath the submucosa of the pelvis. The left kidney showed no inflammatory changes.

In both animals of group two, the patency of the ureter was found to have been re-established at the time of autopsy. Neither kidney was infected in dog Number 19, and in dog Number 20 the right kidney was only mildly infected as shown by the microscopic slides. Better kidneys were found in group two, Numbers 19 and 20, than in group one, Numbers 17 and 18. We attributed this fact to the delayed exposure of the end of the ureter to infected bowel content. Again we believed we had obtained results which indicated that the lumen of the ureter was not the transporting agent for renal infection in these cases.

In group three, dog Number 25, the right ureter was ligated and transplanted between the mucosa and muscularis without making an opening in the mucosa. Urine taken from the right kidney at the time of operation was sterile. Even though the end of the ureter was ligated and not exposed to infectious material, the right kidney showed a marked inflammatory reaction after nine days. The complete record of dog Number 25 follows:

Dog No. 25.—Operation was performed December 18, 1929, and the dog was anesthetized for study nine days later. The peritoneum was normal. The right kidney was twice the size

of the left and showed many large veins over its surface. Culture obtained from the right kidney showed staphylococci. On section thin bloody fluid escaped from the pelvis. The parenchyma was of normal thickness, and the markings were distinct. The right ureter was twice the size of the left. The anastomosis was well healed. A catheter passed down the right ureter failed to demonstrate an opening in the mucosa.

Microscopic sections of the right kidney showed a heavy leukocytic infiltration throughout. There was a great deal of hemorrhage. The left kidney showed no evidence of pyogenic infection, but the epithelium of the tubules was destroyed by cloudy swelling.

The tendency for the re-establishment of drainage in groups one and two of these experimental operations suggested to us that we might decrease the period of obstruction in the ureter and obtain even better results. So in group four, dogs Numbers 27, 28, and 29, the right ureter was ligated with No. 1 plain catgut and transplanted by the Mayo technic. In each case sterile urine was obtained at operation. These dogs were allowed to live fifteen, twenty-three and twenty-four days, so that the pathological changes, if any, would be well developed. The complete records of group four follow:

Dog No. 27.—Operation was performed February 24, 1930. The postoperative course was uneventful except for some loss of weight. The animal was anesthetized fifteen days after operation and urine obtained from the right kidney for culture showed streptococci and bacillus coli. The peritoneum was smooth and glistening throughout. There were a few adhesions in the region of the anastomosis. There was a small localized abscess in the retroperitoneal area at the site where it had been opened to liberate the ureter at the time of the original operation. The right kidney was slightly larger than the left; otherwise they both appeared normal. The right ureter was twice the size of the left. On section the right kidney showed no gross pathological changes. A catheter passed down the right ureter entered the sigmoid without difficulty. There was a small abscess in the wall of the sigmoid where it had been penetrated by the retention suture.

Microscopic sections of the right kidney showed a few small areas of cellular infiltration near the pelvis, otherwise the kidney showed only the changes of cloudy swelling. The left kidney showed a marked inflammatory reaction with abscesses throughout the cortex.

Dog No. 28.—Operation was performed February 27, 1930, and the postoperative course was normal. The dog was anesthetized for study twenty-five days after operation. The abdominal cavity was clean. The large bowel was slightly adherent to the bladder. The anastomosis was well healed, and urine obtained from the right kidney showed staphylococci, which was thought to be a contamination, as the microscopic examination of urine showed only a very occasional pus cell. Grossly, the right kidney showed no changes from the left. A catheter passed down the right ureter entered the bowel without obstruction.

Microscopic sections of the right and left kidneys showed no evidences of inflammatory reaction. The changes of cloudy swelling were present in both.

Dog No. 29.—Operation was performed March 3, 1930, and the postoperative convalescence was uneventful. The animal was anesthetized for study twenty-three days after operation. There was a slight wound infection, but the peritoneum was smooth and glistening. There were a few adhesions in the area of anastomosis. The right kidney appeared smaller than the left. Urine obtained from the right kidney for culture was sterile. On gross section the right kidney showed a few areas of ecchymosis in the cortex and medulla. The pelvis was of normal size. A catheter passed down the right ureter entered the bowel without obstruction.

Microscopic sections of the right kidney showed a marked inflammatory reaction throughout, with abscess formation. The left kidney showed a cellular infiltration beneath the mucosa of the pelvis.

In all three cases of group four the right ureter was patent throughout at autopsy. Two dogs, Numbers 27 and 29, developed a bilateral renal infection, and only one, Number 28, showed uninfected kidneys on microscopic examination. The results in this group were indicative of the value of protection to the end of the ureter and the possibility of using some type of obstruction to obtain this protection.

SUMMARY

In our hands the transplantation of the ureters to the sigmoid in dogs is highly unsatisfactory by the Mayo technic. In every case the kidney became infected and closure of the ureterosigmoidal opening by the mucosa of the bowel occurred in five of the seven unilateral transplants. In the two bilateral transplants the ureteral openings were markedly stenosed.

The completed Coffey technic gave slightly better results. Of the eight dogs, four showed bilateral infection, three showed infection in only one side, and one showed no evidence of infection but was hydronephrotic on one side. Complete closure of the ureteral opening occurred in only one ureter.

The unilateral Coffey operations revealed kidneys in which there was no microscopic evidence of pyogenic infection, yet the dogs never appeared well after operation.

Believing that the kidneys became infected by means other than the lumen of the ureter, we obtained infected kidneys in two cases in which the ureters were still completely obstructed at autopsy. The lymphatics must be given serious consideration as a means of transmitting infection to the kidneys. A clinical case showed the infection to begin while the catheters were still in the lumen of the ureters. The excellent work of Sweet and Stewart adequately describes the lymphatic route.

Solution of the problem of preventing ascending renal infection probably depends upon the discovery of means to prevent infection through the lymphatics. Partial success in this direction was obtained in our experimental cases in which we tried to protect the exposed end of the ureter for a time from infected material. These results suggest that a new technic for transplantation with this principle in view might lessen the tendency to renal infection.

Both Coffey and Kirwin have recently described new technics whereby the end of the transplanted ureter is protected. In a personal communication Coffey states that his results in dogs with this new technic indicate that it may supersede his tube technic when single ureters are transplanted.

Until a uniformly successful procedure is evolved, it would seem the better surgical judgment to use ureteral transplantation only in those cases where older and better understood methods are impossible.

REFERENCES

1. Coffey, R. C.: Transplantation of the ureters into the large intestine. Surg., Gynec, and Obst., Nov. 1928, 593-621.
2. Coffey, R. C.: Bilateral submucous transplantation of ureters into large intestine by tube technic. Clinical report of twenty cases. Jour. A. M. A., Vol. 93, 1929, 1529-1538.

3. COFFEY, R. C.: Experimental transplantation of ureter in which a transfixion suture is used to complete the anastomosis. N. W. Med., Vol. 29, March, 1930, 128.
4. COFFEY, R. C.: Personal communication.
5. FIFIELD, L. R.: Primary Neoplasms of the Urinary Bladder. H. K. Lewis & Co., London, 1928.
6. KIRWIN, G. J.: A study of ureteral transplantation. Am. Jour. of Surg., Vol. 8, January, 1930, 1-27.
7. MCKENNA, C. M.: Transplantation of the ureter. Jour. Urol., Vol. 19, 1928, 527-540.
8. MAYO, C. H., and WALTERS, W.: Transplantation of ureters into rectum. Jour. A. M. A., Vol. 82, 1924, 624-626.
9. SWEET, J. E., and STEWART, L. F.: The ascending infection of the kidneys. Surg., Gynec. and Obst., Vol. 18, 1914, 460-469.
10. TURNER, G. G.: The treatment of congenital defects of the bladder and urethra by transplantation of the ureters into the bowel; with a record of 17 personal cases. Brit. Jour. of Surg., Vol. 17, 1929, 114-178.

PYO-URETER

REPORT OF CASES

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At the 1910 meeting of the American Association of Genito-Urinary Surgeons, Fowler presented an article entitled "Uropyonephrosis of Only Remaining Kidney; Nephrectomy. Pyoureter of Other Side with Peristaltic Contractions of the Ureter Observed Three Years after Complete Nephrectomy."

In recently reading over his very excellent and interesting case report together with the copious discussion which followed, I was quite impressed by the fact that the discussion centered almost entirely on the first part of the title. Much was said about the difficulties of operating on a single kidney but comparatively little on the then unusual phenomenon of observed peristaltic contractions of the ureteral stump and the importance that it might play in the prognosis of the case.

As far as I have been able to ascertain, Fowler's was the first article of its kind to be written in this country, and the fact that up to this time very little on the subject had appeared in the literature of any country probably accounts for the trend of the discussion of Fowler's presentation. Since then it has become a generally accepted fact, due doubtless to the experimental work of Latchem and the clinical observations of several others, that peristaltic contractions do take place in certain ureteral stumps, notably those containing calculi, pus, or both, and that such pathological rests may constitute a menace to the patient's welfare.

According to Fronstein, these rhythmical peristaltic contractions depend in part upon the presence of nerve centers which are situated either in the ureteral walls or in the surrounding connective tissue. According to Latchem, the peristaltic movements will cease when there is nothing within the ureteral lumen, such as urine, pus or stones, to stimulate the nervous mechanism to action. This explains Latchem's further experimental observation, that the muscular coat of the ureter hypertrophies in

the case of complete obstruction and atrophies in the ureter wherein drainage is more or less free.

Latchem's experiments also showed that there is little or no absorption of the contents of a distended ureter.

We have briefly, therefore, according to Fronstein and Latchem, the physiological reason for the development of an empyema of the ureteral stump. Given an infected ureter whose corresponding kidney has been removed, whether or not the stump will become a pus pocket depends chiefly on two factors: (1) the presence of some obstruction, such as stone, stricture or kink; (2) injury to the nerve supply of the ureter, either by operative trauma or peri-ureteritis and consequent scar formation. Where obstruction occurs either complete or sometimes partial, dilatation and retention of pus in varying amounts are likely to ensue. Where the nerve supply has been damaged, especially in a peri-ureteritis, narrowings and pockets are likely to develop due to loss of tone on the one hand and cicatricial contractions on the other.

The greatly distended ureter, present prior to nephrectomy, is, of course, always a potential source of pyo-ureter. But fortunately in a ureter which is anything like normal, the suppurative condition which as a rule follows a suppurative condition of the kidney, usually disappears after the removal of the diseased kidney. This is in accord with Lorin, who says that, if there is a free outlet, pus will usually drain out regardless of extensive damage to the ureter.

Stone is the chief etiological factor by far in the majority of the reported cases of non-tuberculous pyo-ureter.

Israel, who was among the first to describe the subject, collected four cases in 900 nephrectomies. Fronstein saw three during twenty years of active practice. Two of his cases were attributed to stricture and one to stone. In one of his stricture cases, there were two ureteral stumps, both of which he removed. One stump was 3 cm. wide while the other was not enlarged.

Hunt, in his very recent comprehensive article on the subject, reports one case of non-tuberculous pyo-ureter due to stricture and states that it is the only one he could find in a careful search of the records of the Mayo Clinic, in which ureterectomy was necessary subsequent to nephrectomy for pyonephrosis. He

reports four other interesting cases due to stone, in one of which ureterolithotomy alone brought about a successful outcome. In the other three cases, ureterectomy, either partial or complete, was done.

In this same report, Hunt's figures referable to the tuberculous type of pyo-ureter are illuminating. He states, "in no instance in the series of approximately 574 cases in which nephrectomy was performed for renal tuberculosis during the years 1919 to 1928 inclusive, have I found subsequent ureterectomy recorded."

Hyman has reported three cases in which empyema occurred in the short remaining stumps following incomplete ureterectomy. Stone was responsible for one of these cases.

Read's case, likewise a recent one, was unique in that the empyema occurred in a ureter which had been transplanted into the bladder. Before the nephrectomy, the underlying cause of the pyuria, namely, stricture at the site of the transplantation, had begun to manifest itself.

Roedelius has reported two cases, one due to stone and the other to stricture.

Among other observers who have reported at least one case are the following (the etiological factor is placed in parentheses):

Latchem (stone); Chabanolle (stone); Brongersma (stone); Enderlen (stricture); Brutt (stricture); and Klika (stone). In Klika's case, there were three stones in the lower end of the ureter and a groove running along the mesial side of them, through which the urine had evidently passed prior to nephrectomy.

It is noteworthy that in some of the foregoing cases long periods of time elapsed between the nephrectomy and the development of symptoms leading to the diagnosis of pyo-ureter. Thus in the stone case of Brongersma twenty-three years intervened, and in the stricture case of Roedelius seventeen years. In the majority of the cases, however, one to three years was the interval.

Among the shortest intervals between nephrectomy and the appearance of symptoms indicative of pyo-ureter are those of Klika (six weeks), one of Hunt's stone cases (six weeks),

Read's case (two months) and Cases 3, 4 and 5 reported in the following.

The probable chief factors upon which this interval depends are the type of obstruction, the degree of infection, the amount of damage to the ureter prior to nephrectomy and the personal equation of the patient.

The principles employed in the successful treatment of pyo-ureter are directed toward—

1. The eradication of the pus pocket (complete or partial ureterectomy),
2. Establishment of better drainage (uretero-lithotomy for the removal of an obstruction such as stone or enlarging the ureteral orifice by fulguration or the dilating of strictures by bougies),
3. The removal of infected ureteral contents by non-operative means (irrigation),
4. A combination of 2 and 3.

In the majority of the cases reported as cured, the method employed was ureterectomy either complete or partial, the latter being employed usually when a stone is present and a segment of ureter containing the stone is removed. It would seem from Hyman's experience that complete removal of the ureter instead of partial should be done whenever possible.

Uretero-lithotomy for stone is sometimes successful, to wit one of Hunt's cases. But despite the good result in this case, he prefers complete ureterectomy.

Doubtless many cases of pyo-ureter could be prevented by proper treatment of the ureter at the time of nephrectomy. While I cannot agree entirely with Hunt, who at the time of nephrectomy makes it a practice in the ureteral stone cases to remove the ureter either entirely or a portion of it containing the stone, still much is to be said in favor of his argument. Against it, of course, is the fact that there are comparatively numerous instances in which stones which are allowed to remain in ureteral stumps do not subsequently cause trouble. But as far as the prophylactic treatment of pyo-ureter is concerned, it behooves every surgeon who contemplates removing a non-tuberculous kidney to make, wherever possible, a complete preoperative study of the ureter as well as the kidney itself. And if confronted by

any one ureteral finding such as stone, stricture in the presence of pus or the dilated atonic type of ureter, the idea of performing ureterectomy at the time of the nephrectomy should be given very serious consideration. In this connection it is well to bear in mind that, if the patients' condition will permit, ureterectomy done at the time of nephrectomy should ordinarily be much simpler than at a later period when adhesions arising from a periureteritis are prone to be both dense and numerous. This is well shown by the following description of an operation recently performed by my associate, Dr. Keyes. The procedure he employed also illustrates a method of handling a type of pyo-ureter which is well nigh impossible of removal.

"In this patient, a thirty-five year old colored woman, there were two ureters. One draining the upper portion of the kidney, which was a pyonephrotic sac, proved to be a widely dilated pyo-ureter. The other ureter drained the lower portion of the kidney, which appeared to be relatively normal.

"The nephrectomy was uncomplicated excepting that the widely dilated pyo-ureter was so adherent at the pelvic brim and so tense with pus that it seemed wiser to bring it to the skin for drainage rather than to attempt a complete ureterectomy and with the realization that a secondary operation would be needed. This secondary operation was performed May 20, ten weeks after the first one. The pelvic ureter was exposed extraperitoneally but everything was so densely adherent in the right side of the pelvis that it was necessary first to open the peritoneum and remove the adherent tube and ovary on that side, then to lift up the peritoneum from the posterior pelvic wall mesial to the ureter and close the peritoneum.

"It was then found that the ureter was a dilated and convoluted tube set in a mass of dense adhesions. At no place could a line of cleavage be found. It was deemed unsafe to attempt complete ureterectomy so the mass of adhesions was split open into the coils of ureter from which thick, stinking pus escaped (bacillus pyocyaneus). Even excision of the mucosa was found impracticable so the whole interior of the ureter was well cauterized with the high frequency current, a 22 F. urethral catheter sutured into the lowest loop right against the bladder and another tube inserted above.

"The accessory ureter was not looked for or discovered.

"After operation drainage was extremely profuse. Potassium permanganate irrigations were done at first every hour during the day and finally the patient left the hospital with a small tube one month after operation. Curiously enough the only postoperative complication was the distress she suffered from the pressure of one of the silkworm skin sutures.

"Up to the time of leaving the hospital it was impracticable to use Dakin's solution for irrigation because this caused bladder irritation. It is hoped that Dakin's solution may shortly be practicable and may occasion the healing of the wound."

While the purpose of this paper is to deal chiefly with the non-tuberculous pyo-ureter, reference is made to the tuberculous type merely to emphasize again its relative scarcity.

Approximately 222 nephrectomies have been performed on the Bellevue Urological Service during the years 1916 to 1929 inclusive. This particular interval was chosen because 1916 represents the beginning of the present urological service, that is, the time when the individual urological services of the four different divisions of the hospital were consolidated. The total number represents all the nephrectomies performed during this period for whatever purpose nephrectomy was indicated. Of the 222 nephrectomies, tuberculosis was the etiological factor in about ninety-eight cases. Of this number a subsequent ureterectomy was performed in only one, and even in this instance the operation was probably needless, as will be shown in Case 1. The tuberculous cases reported herewith illustrate the fate of the ureter which remains after the removal of a tuberculous kidney, and are in accord with the usual observations, namely, that such a ureter usually takes care of itself and gives rise to trouble only in rare instances. Legueu, while performing a hysterectomy three years after a nephrectomy for tuberculosis, found the ureter to be a dense sclerotic cord. Lorin, in examining a series of patients wherein the postoperative course was longer, found obliteration of the ureter.

Case 1.—The tuberculous right kidney of a fifteen year old Italian girl was removed in Bellevue March 29, 1926. Her preoperative symptoms of dysuria, instead of becoming better, became steadily worse despite various bladder treatments. Several cystoscopic examinations, made at intervals of one to six months, all showed marked inflammation and edema in the region of the right ureteral orifice. Finally ureterectomy was decided upon as a possible means of relieving the patient. This was done February 24, 1927. The patient was not relieved, however, until the other ureter was transplanted into the bowel (May 21, 1929). This was undertaken in the full realization that it was a hazardous procedure but the patient was becoming desperate. The transplantation accomplished

results. Since this operation the patient has put on weight, is in fine spirits and of course no longer suffers from dysuria.

Apparently the only good that came of removing the ureteral stump was to show the operator what usually happens in such a case. Very hard and as large as one's thumb at the time of the nephrectomy, the ureter had now dwindled down to the size of a lead pencil. When split longitudinally, the wall had a grayish edematous appearance which in places was yellowish. No muscle tissue could be recognized. The pathologist's report was tuberculous ureteritis.

The data for the second case were kindly furnished to me by my colleague, Dr. A. R. Stevens, from his private practice. The findings, in so far as the tuberculous ureter was concerned, were similar to those of Case 1.

Case 2.—It was found, during the postoperative course of a thirteen year old boy on whom a suprapubic cystotomy had been performed for calculi and a little later a perineal section for an abscess behind the bladder, that the left kidney was also probably the seat of trouble. A left nephrectomy was performed and the kidney found to be tuberculous. The ureter was as large as one's little finger and stony hard, but no attempt was made to remove it, on account of the patient's weakened condition.

Seven months after the nephrectomy, it was decided to do a ureterectomy because it was thought that the kidney and bladder wounds, which had not yet healed, would be favorably influenced thereby. On performing the ureterectomy, the operator was surprised to find the ureter *soft and pliable and about the size of a lead pencil.* The patient remained in the hospital for more than a year but ultimately the perineal and kidney wounds healed entirely. The suprapubic wound did not fare quite so well although when the patient was last seen, in 1929, he reported that it remained closed most of the time.

Of the remaining non-tuberculous nephrectomies, approximately 124, a record of subsequent removal of the ureter on account of symptoms referable to it could be found in only two of them. It should be mentioned, however, that in recently discussing the incidence of the Bellevue pyo-ureter cases with Dr. Keyes, he told me he had seen, in another clinic, a man whose kidney had been removed at Bellevue. This patient was between twenty and thirty years of age and, while the nephrectomy had been performed more than a year previously, he was still suffering from the same symptoms for which his kidney had been removed. Examination revealed a dilated ureteral stump.

If this be added to the other two Bellevue cases, it makes the Bellevue incidence somewhat higher than that reported from other clinics with the possible exception of the cases reported by Hunt.

The following cases of non-tuberculous pyo-ureter are typical and illustrate points brought out in the foregoing. Two of them were due to stones and one to a narrowing of the lower end of the ureter.

Case 3 illustrates the difficulty in attempting to single out the type of ureteral stone which will not give rise to trouble following nephrectomy. It shows also how brief may be the interval between nephrectomy and the appearance of the pyo-ureter symptoms. It is of further interest because there was a "Y" ureter, one branch only of which (the one containing the stones) was dilated but both branches of which were the seat of a definite ureteritis cystica.

While, strictly speaking, the operation performed was a partial ureterectomy, so little of the ureter was left (not over 1.5 cm.) that the procedure could almost be classed as a complete ureterectomy.

Case 3.—This patient, E. B., admitted to the Urological Service of Bellevue Hospital, April 1, 1926, complained of pain in the right loin. For nineteen years he had experienced intermittent burning on urination. While in the army in 1919 a diagnosis of renal calculus of the right kidney was made. Nephrotomy was performed but no stone was found. About three months after that, however, he passed a stone about the size of a pea. Since that time, that is, since 1919, his burning on urination persisted and he had attacks of pain in the right loin radiating down to the right testicle. He has not suffered from increased frequency of urination. He brought with him to the hospital a very good X-ray film showing a fairly large calculus which appeared to be in the pelvis of the right kidney and several small calculi apparently in the right ureter low down.

Catheterized ureteral specimens showed the function of the right kidney to be very poor as evidenced by the indigo-carmin and urea tests. The function of the left kidney was apparently excellent as evinced by the same two methods.

It was decided that the best plan of operative procedure would be to first remove the stone from the right kidney and then at the same sitting to remove the ureteral calculi through a Gibson incision, provided the kidney operation had not taken too long and the

patient's condition would warrant proceeding with the ureterotomy.

On April 6, five days after admission, the right kidney was exposed by means of the usual oblique loin incision. Somewhat to our surprise the kidney was found to be less than half the normal size and the remaining parenchyma was almost nil. The kidney, stone and all, was removed without any further investigation. An interesting feature of this operation was the finding of a structure which resembled a supernumerary ureter but it was so tangled up in a mass of adhesions that it was almost impossible to identify the structure with certainty.

Since the kidney itself had been removed instead of the kidney stone only, as at first intended, the plan of removing the ureteral calculi was abandoned. *It was argued they would probably never give rise to further trouble and that the patient would therefore be spared the necessity of an additional operation.*

The patient made an uneventful recovery and was discharged from the hospital April 29, 1926, in excellent condition and with no urinary symptoms. But realizing the possibility of further trouble, he was advised to report back to the hospital should any of his old symptoms return.

On July 8, scarcely more than two months after his discharge, he was readmitted to the Urological Service with symptoms of marked dysuria. He stated that he had been free from urinary symptoms for one month after leaving the hospital but since then had suffered from very marked increased frequency of urination, voiding every half hour by day and once or twice at night with considerable pain and burning. These symptoms had become much aggravated about ten days before his re-admission.

Cystoscopy was performed by the resident urologist, who passed a radiographic catheter up the stump of the right ureter. The resulting X-ray picture did not prove to our entire satisfaction that the shadows noted in the lower ureteral region at the time of his previous sojourn in the hospital were shadows of calculi. There was too much space between the supposed stone shadows and the catheter shadow.

In reading over the account of his previous operation at Bellevue, it was noted that there was some question as to the presence of a double ureter on this side. A few days later, with this in mind, cystoscopy was again performed and a diligent search for a second ureteral orifice was made but none found. Remembering the possibility of a "Y" shaped ureter with the bifurcation low down, two radiographic catheters were passed into the only ureteral orifice which could be found, hoping that if such a condition existed each catheter might find its way into a separate branch of the "Y." The X-ray picture with these catheters in place was not particularly useful in proving our point and it was not until an X-ray film was made after sodium iodid was injected up both catheters that it was be-

lieved we were dealing with a dilated ureter containing calculi and possibly a second ureter.

While the patient was still on the cystoscopic table a sterile solution of indigo-carmin was injected up one of the catheters and immediately quite a quantity of fairly thick pus was seen to exude from the ureteral orifice alongside the catheter. The specimen collected from the left kidney showed it to be in apparently very good condition.

A diagnosis of pyo-ureter of the remaining stump with the probable presence of ureteral calculi was made and operation again decided upon. On July 13, 1926, through a Gibson incision, we found the remains of a "Y" shaped ureter with the bifurcaton, as near as we could tell, within one inch of the bladder. In one branch of the "Y" were three stones corresponding to the shadows seen in the plates. The operation presented no especial difficulties. Both ureters were removed to a point just below the bifurcation. This left only about 1.5 cm. of the single stump. The patient again made an uneventful recovery and left the hospital about four weeks later with none of the symptoms which he presented on admission. He was last seen about a year after his second operation and reported no return of symptoms up to that time.

The next case (4) was treated by means of partial ureterectomy. The portion of the ureter resected included the cause of obstruction, namely, a large stone. While the immediate result was satisfactory, we were unfortunately left in some doubt as to the final outcome.

Case 4.—On March 29, 1921, A. M. was admitted to one of the general surgical services of Bellevue Hospital, soon after he had been caught between the radiator of one automobile and the rear end of another which was backing. A left pyonephrosis developed and the kidney was removed May 21, 1921. The patient was discharged on July 12, 1921, and re-admitted June 6, 1922 (this time to the urological service), on account of severe pain in the left inguinal region which radiated down to the penis. A considerable amount of pus was found in tthe bladder urine. Cystoscopy revealed normal urine from the right kidney and a catheter could be introduced up the left ureter for only 1 cm. Nothing was obtained through the catheter and nothing was seen to emanate from the ureteral orifice. The bladder mucosa appeared to be perfectly normal and this fact, coupled with the finding of pus in the bladder urine and normal urine from the right kidney, led to the conclusion that the pus probably came from the left ureteral stump Since his symptoms disappeared soon after the cystoscopy, however, the patient was discharged June 25, 1922.

On July 11, 1922, he was re-admitted for pain in the left lower

quadrant and an X-ray showed a stone measuring 2 by 5 cm. near the lower end of the left ureter, but his symptoms again disappeared and he was discharged at his own risk.

On August 4, 1922, the patient was admitted for the fourth consecutive time to Bellevue. On this occasion the pain in his left loin and left lower quadrant was so severe that he did not hesitate to agree to an operation. His only other symptoms were increased frequency of urination.

On August 25, the following day, through a somewhat modified Gibson incision, the left ureter was exposed. It was found to be about 3 cm. in diameter. A stone about the size of one's thumb was removed from a point in the ureter a little above the bifurcation of the iliac vessels. Just above the stone was a walled-off abscess within the ureter, containing about 10 c.c. of thin milky pus. This was accidently ruptured and the part of the ureter which had contained the abscess and the part containing the stone, a segment in all of about 10 cm., was removed. More of the ureter would have been removed except for the dense adhesions between it and the peritoneum, which was torn once during the procedure just described. A large cigarette drain was placed at both the upper and lower angles of the wound with a large rubber tube drain leading down to the region of the pus.

The patient was not discharged from the hospital until October 23, 1922, at which time there were two sinuses, one in the old nephrectomy scar and another in the left lower quadrant. At his only recorded visit to our return clinic on November 2, 1922, there was still a small sinus in his loin with a larger sinus in the left iliac region. Both wounds were clean but gave rise to a slight discharge. His general condition, however, was excellent. There is no note of his having been seen by anyone on our staff since this last date.

I am again indebted to Dr. Keyes for another case (5) which illustrates what may be accomplished by the non-operative treatment of pyo-ureter due to stricture.

Case 5.—H. B., a twenty-one year old woman, according to an X-ray examination, had stones in both kidneys.

On May 14, 1921, one large and several small stones were removed from the right kidney. Two weeks later the left loin became painful and tender with an increase in temperature. The left kidney, very adherent and full of thick pus, was removed. No stones either in the kidney or its ureter were found.

The patient left the hospital three weeks after the last operation but from that time until comparatively recently has experienced more or less trouble referable to the urinary tract. At first there were pains, without fever, in both loins. The right-sided pain was due to a stone (shown by X-ray) in the right ureter. This stone

was finally passed in October, 1921, and relief experienced. Catheterizations and dilatations of the right ureter, however, were subsequently necessary before her right side ceased giving symptoms.

The pain in her left loin was shown by cystoscopy to be due to a pyo-ureter. Great gobs of pus were found in the bladder, while urine from the right ureter was clear. Washings of the left ureteral stump (whose capacity was about 10 c.c.) confirmed this and while relief always followed irrigations of the left ureter, the loin pain, though becoming less severe, returned with regularity. The pain usually lasted two to three days and occurred every two to three months. The pus in the bladder had diminished appreciably.

In 1925, as a result of more left-sided colics, the left ureter was again irrigated and its orifice enlarged by electro-cauterization. Irrigations of the left ureter were continued at longer and longer intervals, until finally in November, 1928, she presented none of her old symptoms and her urine showed no pus.

While this patient has had another right-sided colic (probably due to a kink) as recently as January, 1930, her left ureter has given her no further trouble. She feels well, has put on 20 pounds in weight and her urine sparkles.

Both Roedelius and Brutt have reported treating cases of pyo-ureter by means of irrigation alone.

"All is not gold that glitters." Case 6 is appended merely to show how chronic prostatitis may simulate pyo-ureter. For this, I am also indebted to Dr. Keyes.

Case 6.—A. Z., male, aged 31, entered Bellevue Hospital in June, 1919, with stones in both kidneys. The larger stones were in the left kidney pelvis. On the right side one stone was stuck in the upper ureter. The right loin was accordingly opened. "His kidney is quite adherent, the pelvis distended and a triangular oxalate stone fixed in the upper end of the ureter about 3 cm. from the kidney pelvis." One small stone was found in the kidney pelvis and one in a middle calix. The convalescence was stormy but when he left the hospital, eight weeks after the operation, the phenolsulphonephthalein output was 55 per cent in the first hour after intramuscular injection and he was so well that he refused operation upon his left kidney until October, 1925. A calculous pyonephrosis was removed and his convalescence, except for an epididymitis, was uneventful.

Three weeks after nephrectomy he passed a considerable amount of thick pus in the urine. Three days later the urine was grossly clear and the left ureter was catheterized, the catheter stopping at 22 cm. Two c.c. of 1 per cent mercurochrome were left in the ureter. This catheterization was repeated five times during the next four months. On three of these occasions 1/500 silver nitrate solu-

tion was injected. The urine from the right kidney pelvis never contained any pus. He was having discharges of creamy pus about once in six weeks, regardless of the injections. (No accumulated fluid was ever drained from the ureter when the catheter was introduced.) In May, 1926, seven months after nephrectomy, the pyuria became rather more continuous and was attacked for the first time by prostatic massage. This promptly diminished the output of pus. Prostatic massage was continued for one year before the pyuria permanently cleared up. The patient was last seen July, 1929, with only a few pus cells in the urine and no symptoms.

COMMENT

1. Pyo-ureter is caused chiefly by two factors: (a) obstruction, and (b) injury to the nerve supply of the ureter resulting in absence of peristalsis and lack of tone.

2. The chief etiological factor in most cases of pyo-ureter is ureteral stone.

3. While the relative occurrence of pyo-ureter, including even the stone cases, is small, it is a definite menace to life. More attention, therefore, should be directed toward the prevention of its development. This can best be accomplished by proper treatment of the ureter and its contents at the time of nephrectomy, which pre-supposes a careful study of the ureter prior to nephrectomy.

4. While a few cases may be successfully treated by non-operative measures such as fulguration and irrigation, ureterectomy, especially complete ureterectomy, is indicated in the great majority of cases.

REFERENCES

BRONGERSMA, H.: Un cas d' urétérite se manifestant 23 ans après la nephrectomie. Association Française d' urologie, 1921, xxi, 583-586.

BRÜTT, H.: Zur Chirurgie des Empyems des Ureterstumpfes. Beitr. z. klin. Chir., 1919, cxv, p. 648.

CHABANOLLE, L. DE: Indications de la nephrectomie pour calcul de l'uretère. La Presse Médicale, 1921, xxix, p. 552.

ENDERLEN: Über das Empyem des Ureterstumpfes. Deutsche Ztsch. f. Chir., 1924, clxxxix, 19-23.

FOWLER, H. A.: Uropyonephrosis of only remaining kidney; nephrectomy—pyo-ureter of other side with peristaltic contractions of the ureter observed three years after complete nephrectomy. Trans. of Amer. Assn. of G-U. Surg., 1910, V, 35.

FRONSTEIN, R.: Das Empyem des Harnleiterstumpfes. Ztsch. f. urol. Chir., 1926, xx, 183-190.

HUNT, V. C.: The necessity for operations on the ureter, including ureterectomy subsequent to nephrectomy. Jour. Urol., 1930, xxiii, 43-54.

HYMAN, A.: Empyema of the ureteral stump following incomplete ureterectomy. Ann of Surg., Sept., 1923, 387-397.
ISRAEL, J.: Empyem des Ureters nach Nierenextirpation. Deutsche med. Wchnsch., 1908, xiv, 617.
KEYES, EDWARD L.: Personal communication.
KLIKA, M.: Kanalisierter Stein in ein Ureterempyem. Ztsch. f. urol. Chir., 1921-22, viii, 108.
KÜMMELL: Das spätere Schicksal der Nephrektomierten. Ztsch. f. urol. Chir., 1913, i, 375.
LATCHEM, R. L.: An experimental study of the ureter after nephrectomy; report of a clinical case of pyo-ureter. Jour. of Urol., 1922, viii, 257-279.
LORIN, H.: L'uretère après la Nephrectomie. Archives Urologiques de la Clinique de Necker, 1914, I, 145-196.
READ, J. S.: A ureteral stump (non-tuberculous) as a source of pyuria; case report. Jour. Urol., 1929, xxi, 103-107.
ROEDELIUS, E.: Ureter Stenosen. Ztsch. f. urol. Chir., 1917-19, iv, 174-203.
STEVENS, A. R.: Personal communication.

A STUDY OF THE TESTICLE: EFFECTS OF INCREASED TEMPERATURE, TRANSPLANTATION AND HORMONE PRODUCTION*

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For centuries it has been known that occasionally the testicles of domestic mammals and of man fail to descend into the scrotum; one or both organs may be retained in the abdomen or within the inguinal canal. The testes of all vertebrate animals have their embryonic development well within the abdomen and in all excepting the mammal group this position is characteristic throughout life. In the lower egg-laying mammals the testes are abdominal, but as we examine the ascending scale of mammals there is apparent a gradual tendency for the testes to descend. In some lower forms (bat, etc.) the testicle comes to occupy a position against the anterior abdominal wall during the period of seasonal germ cell production, and the anterior wall becomes perceptibly thinner than in other areas. Still more pronounced is the case of many wild rodents whose testes push through a thin area into a beginning scrotal pouch while they are seasonally active in germ cell production, and recede into the abdomen at the end of activity. The more nearly domesticated rodents (rabbit, rat, guinea pig, etc.) usually have a continuous testicular activity with germ cells present at all times of the year, and in these the testicles remain more or less continuously in the scrotum; the latter structure is a bilateral outpouching of the inguinal region, but the canals remain open and the testes can be withdrawn into the abdomen. On relaxation of the muscles the testes redescend into the scrotum, for they are fixed to its lower surface (gubernaculum). In still more advanced development (dogs, horses, monkeys, man, etc.) the scrotal outpouching becomes closed off from the abdomen with a continuous scrotal residence of the testicle.

It has now long been known that testicles of the higher mam-

*The investigations here reported have been aided by a grant from the Committee on Research in Problems of Sex of the National Research Council; grant administered by Professor F. R. Lillie.

mals do not produce germ cells unless they occupy the scrotum. When both of them are retained in the abdomen the animal (including man) is sterile. This condition has generally been attributed to a faulty embryology of the testicle without any appreciation of the potentialities of the undescended organ. Our studies have thrown an entirely different light on the situation and serve to endow the scrotum with a real and vital function for germ cell production. No longer ago than 1921 Cunningham in his book, Hormones and Heredity, stated, "Various causes have been suggested for the formation of the scrotum, but no one has ever been able to suggest a use for it."

In the following paragraphs the outline of our experiments will briefly accquaint one with the steps that have led us to the conclusions that the scrotum not only has a real function but that specifically it is a heat regulating mechanism; and further that the mechanism is necessary to realize the production of spermatozoa by the testis.

Experimental Cryptorchidism.—When one simply retracts an active testicle of an adult guinea pig through the open inguinal canal into the abdomen and prevents its scrotal return, one will find that within a week all seminiferous tubules of the organ are totally disorganized. The former germinal epithelium (spermatogonia, spermatocytes, spermatids and spermatozoa) is undergoing degeneration and dissolution. The lumen of the tubules will be filled with debris and many "giant cells" will be present. When abdominal retention has existed for two weeks practically the entire former contents of all tubules will be absent. There is no further cell division and the only cells present will be a scattered few spermatogonia and sertoli cells. This degeneration occurs despite the lack of surgical injury to the organ, and when blood vessels and nerve connections are normal; furthermore, it results in a progressive shrinkage of the testis, and no further formation of germ cells occurs as long as the testicle remains in the abdomen. Sections of testicles remaining in the abdomen for a year or longer show that the former seminiferous tubules are but a fraction of their original diameter and do not contain any recognizable cell that could give rise to germ cells.

Adult testicles elevated to the abdomen and allowed to degenerate for a few months will recover their normal condition and

produce spermatozoa if they are replaced in the scrotum. Over one hundred cases of experimental cryptorchidism have been prepared by us, using the rat, rabbit, guinea pig, and ram, and without exception the testicles lose their power to produce spermatozoa if they are confined within the abdomen.[7a]

This series of facts clearly shows that the testicle within the abdomen is sterile, not because it develops abnormally, but because of its unfavorable location. This is true for man as well as for the laboratory mammal.

Surgeons have pressed us for information relative to the age in man at which scrotal replacement might possibly serve to restore a normal function to the congenitally undescended testis. We have attempted to supply such information as nearly as possible by duplicating congenital undescent of man in an experimental animal in all its essential features.

The guinea pig, possessing an open inguinal canal, seldom experiences congenital undescent, but we have produced these artifically. Abdominal elevation of the testis from the scrotum ten days after birth is the essential equivalent of congenital retention in man, since normally the guinea pig testicle of that age shows but little cellular activity and spermatozoa do not appear in the seminiferous tubules until the age of fifty to sixty days. One finds that a guinea pig testis placed in the abdomen at such an early age retains its general embryonic condition indefinitely. Four months after elevation one testis removed and fixed for control consists of a single layer of undifferentiated cells in its seminiferous tubules and these do not give evidence of division. The opposite testicle, which was replaced in the scrotum at the time of removal of its partner for examination, was observed ninety days later. It was found to possess normal seminiferous tubules with spermatozoa present in many of them.[7d]

Here, therefore, the testicle had recovered its normal activity and produced germ cells within ninety days despite the fact that it had remained confined within the abdomen for four months. The danger of applying such observed facts to man is recognized, but for those who wish, it may be interesting to note that such a period of congenital (?) cryptorchidism in the guinea pig with recovery upon scrotal replacement, when based upon relative reproductive life or relative total life, corresponds roughly to a human individual of the age of twenty to twenty-

five years. In general it may be stated that in human cryptorchids germ cell production is never realized, whereas in successful scrotal placement the chances are favorable for this attainment even though scrotal placement be delayed to an age of perhaps twenty years. It is entirely possible that this age may be even greater but speculations in the absence of definite observations in man are of little value. It may be stated that surgeons are now practicing scrotal placements of undescended testes of the human individual, particularly in young boys. Many apparently consider the operation should always be done at or before puberty and never later, believing that recovery is impossible once sexual maturity has been attained. This belief is certainly not justified when applied to the experimental animal; recovery has occurred some months after attainment of sexual maturity.

The ascertained facts of such rapid and vigorous testis degeneration following a shifting from the scrotum into the abdomen (in the guinea pig, a distance of approximately two inches) challenges at once an understanding of the cause.

Successive elimination of many different postulates as to the causal factors in degeneration left but one apparently reasonable hypothesis, namely: the idea that differential temperature between the abdomen and scrotum was the cause. A few years ago a program of investigation in this laboratory, directed towards testing this hypothesis, made it more and more certain that the hypothesis was correct. The following studies were carried out and involved examination of hundreds of cases.

A. Abdominal and Scrotal Temperatures.—Simultaneously recorded temperatures from two thermometers inserted through locally anesthetized areas, one into the abdominal cavity and the other through the abdominal cavity, open inguinal canal and into the scrotum alongside the testicle showed that at ordinary room temperatures the scrotum of the adult rat, rabbit and guinea pig was invariably from 1.5 to 4 degrees Centigrade lower than the interior of the abdomen. If observations were made at lower room temperature (15 degrees Centigrade) the difference between scrotum and abdomen was even greater.[12a] This is in keeping with the observed fact that the scrotum in man is subject to great differences. On warm days or after warm baths

the scrotum is greatly relaxed in contrast to its contracted state in cold environments. Harrenstein[4] in a pediatrics hospital in Amsterdam, on sixteen operations for scrotal placement of undescended testes in boys one and one-half to eleven years of age, noted invariably a lower scrotal temperature than abdominal (1 to 7 degrees Centigrade below abdominal temperature), despite the general anesthesia and the operating room temperature. The fact is established, therefore, that the scrotal temperature is consistently lower than that of the abdomen.

B. Scrotal Insulation.—Recognizing the lower scrotal temperature as a fact, one is forced to conclude that the scrotum is an active thermoregulator that functions to reduce the temperature about the testicle. This being true, it should follow that prevention of its heat regulatory function should result in destruction of the germinal tissues of the testis while the latter is within the scrotum. To test this idea we chose the ram as the experimental animal because of its pendulous scrotum, and insulated the latter against loss of heat. Woolen batting was sewed to fit the scrotal contour and an outside waterproofed covering prevented absorption of moisture. Proper precautions were exercised to prevent binding on the scrotum and the animals were permitted to run loose in the barn yard with controls. We determined that the testicle was in a very degenerate condition within eighty days after insulation. All tubules were in stages of degeneration and no spermatozoa were to be found. Thus, merely by preventing the heat regulatory scrotal function, by insulating wrappings, the animal sterilized itself with its own body heat.[10]

C. Exposure to Heat.—In abdominal retention of testes and in scrotal insulation the destructive temperature is but that of the body, which is a few degrees above the normal for the scrotal testicle, and degeneration occurs gradually. Higher temperatures acting for shorter periods were supplied by bathing the scrotum in running warm water controlled to within 0.5 degree Centigrade; by hot pads; by electric lamp and electric stove reflected heat. We determined that a stream of water of 47 degrees Centigrade (body temperature 39-41 degrees Centigrade) passed continuously over the unoperated guinea pig scrotum for one fifteen minute period so affects the testes that

when one removes them ten days after the treatment one finds most or all seminiferous tubules in a high degree of degeneration.[7b] We can sterilize an animal for days, months, or permanently by a properly applied single scrotal bathing with water 6 degrees Centigrade above the normal body temperature.[13] Facts of this kind deserve mature consideration before applying diathermy to the human testis as treatment for epididymitis.

D. Testis Transplantation.—When the fact was determined that a testicle must be located in the scrotum to produce germ cells we made testis grafts in the scrotum by fastening the transplanted tissue to the scrotal wall instead of the previous method of intraperitoneal or subcutaneous transplantation. In the scrotal transplants we have obtained grafts actively producing spermatozoa six months after transplantation, whereas subcutaneous or intraperitoneal grafts do not produce them.[7c]

E. Vasectomy.—The now famous Steinach method of rejuvenation produced by vasectomy has been proved erroneous in all its fundamental conceptions. We have studied testes, the vas deferens of which have been ligated for periods of from ten days to ten months. According to Steinach and others, such operations are followed by testis degeneration, interstitial cell hypertrophy, and supposedly increased hormone production. The dog, ram, rat, rabbit and guinea pig testes do not degenerate nor produce interstitial cell hypertrophy after vas deferens ligation, *so long as the testes remain under scrotal regulatory control,* but operations resulting in adhesions and retraction of the testicle into the abdomen do result in degeneration. Such degeneration, however, is the result of increased temperatures and not vasectomy.[12b,13,14] Since all basic principles of Steinach's rejuvenation conception have been disproved there is no longer justification for continuing its application to man for purposes of rejuvenation. We believe Steinach was misled through ignorance of the high temperature effect.

The above recital of experiences presents briefly the fundamental building stones of our conception of the scrotum as a local thermo-regulator. The conception has been more widely developed in other papers,[7b,12a] and brings into line a multitude of experiences of our own and others. Temperatures below that

of the body are necessary for spermatozoön production in those animals that have produced a scrotum. The bird testicle is more heat-resistant than that of the mammal, for it resides within the body of an animal whose temperature is greater than that of the mammal.

TRANSPLANTATION AND HORMONE PRODUCTION

Testis transplantation has received considerable attention in the last twenty years by some urologists. The procedure has been employed in cases of testicular loss through atrophy or necessary operative removal, and more questionably in cases of alleged "hypogonadism."[5] The latter situation is of particular interest when one understands that up to the present time there is no known criterion by which to determine whether testicular hormone is deficient or superabundant in man.

Testis transplants obviously fall into two classes:

1. Those cases in which tissue from the same animal species is so transferred that it becomes incorporated into the host as a functional secreting mass. When such masses are sufficiently large and produce hormone in sufficient amounts, the animal retains his normal sex inclinations. The ease with which functional grafts are obtained, however, is rather discouraging. In our hands 200 transplantations of small amounts of young rat testes from one host to another, under the most favorable conditions, resulted in the recovery of approximately 60 per cent of the grafts up to six months after transplantation.[7c] Of these, less than one-half could in any sense be considered functional. A palpable nodule at the site of transplantation is by no means a safe criterion of graft persistence.

2. The second class of grafts includes transplants either too large to become successfully vascularized and incorporated, or tissue from different animal species that fails to persist, suppurates, and is discharged—the non-viable grafts. This type of transplantation into man has been invoked as an alleviation of a vast number of ills that befall him, ranging from indigestion, through failing of the general senses, to locomotor ataxia and diabetes. This topic has recently been discussed more in detail elsewhere.[7g] It is implied that through autolysis of the transplant, testis hormone is liberated and exerts effects detectable from one to two years.

It will be apparent that effects reported in man from such autolyzing testis transplants have been based almost wholly upon subjective criteria. Until dependable objective indices are developed for hormone effects in man we will be unable to grant the contentions of positive stimulating effects from foreign testis tissue or the liberation of hormone by such autolyzing masses of transplanted material. Our position in this matter will be appreciated by a brief consideration of experimental results recently obtained.

In a series of studies in our laboratories (Moore and McGee; McGee, Juhn and Domm; Moore and Gallagher; Moore, Price, Hughes and Gallagher) we have developed methods of detecting hormone action in experimental animals. By means of both morphological and physiological changes we are able to detect definite castration signs in the rat and guinea pig, three to seven days after testis removal. Furthermore, we have been able to obtain extracts from the bull testicle (McGee, Gallagher and Koch) that contain the testis hormone in amounts which permit us (1) to inject the substance into animals just castrated and entirely prevent the development of castration changes; (2) to inject animals showing the castration changes and rebuild them to normal states; and (3) to inject animals castrated before the development of sexual maturity that have remained castrated for months and rebuild the normal condition within twenty to thirty days. Thus a knowledge of methods for hormone detection and the successful extraction of the testis hormone afford us means of studying hormone effects by objective rather than by subjective methods.

The male hormone is not species specific but is sex specific. Potent extracts of bull testes serve (1) to stimulate the growth of a castrated cock's comb (McGee, Juhn and Domm), (2) to exercise its preserving effect upon spermatozoa present in the guinea pig epididymis (Moore and McGee), (3) to keep both the seminal vesicles and prostate gland of castrated guinea pigs in active function (Moore and Gallagher), (4) to maintain the normal structural condition of (a) all three lobes of the prostate gland of castrated rats, and (b) of the seminal vesicles of castrated rats (Moore, Price, Hughes, Gallagher). The hormone is not stored within the body but is excreted by the kidneys and can be collected from the urine and reinjected[2] (Gallagher—un-

published). Definite castration changes appear in the rat seminal vesicle and prostate within four days after either removal of the normal testes, or after ceasing injections of the hormone, into castrated rats.

With such facts as the above before us, how are we to regard the possibility of demonstrating effects from non-viable, autolyzing testis transplants?

It should be clear that since castration produces easily detectable morphological changes within two to three days, or that an animal that is being maintained in a normal condition by daily injection of potent hormone doses develops castration changes in similar periods when the injections are stopped, hormone is not stored within the body but is immediately eliminated through the kidneys; daily injections must be maintained in order to prevent development of castration changes. Effects demonstrable for more than two or three days, therefore, are inconceivable. It is still more important, perhaps, to inquire whether such autolyzing transplants liberate any hormone during the course of tissue destruction. This we have attempted to determine by utilization of our sensitive hormone tests. Our results have been reported in some detail elsewhere[7g] and will be mentioned here only briefly.

In both the rat and guinea pig we have removed the two testes and have placed them each in a separate incorporation bed beneath the skin or in the peritoneal cavity. Each organ was cut longitudinally and the material so scattered to afford maximum opportunities for absorption of autolytic products. More than twenty animals have been studied without in any case being able to detect the effect of hormone liberated from the tissue. The indicators employed were capable of demonstrating hormone release in very small quantities during the period of two to fifteen days after operation. At this time the non-viable grafts have usually either disappeared or are represented by a mass of suppurating material. Since our methods are capable of detecting two daily administrations of small amounts of hormone we can only conclude that if hormone is liberated at all by the autolyzing grafts it is in amounts too small to be detected by any means at present known.

Such results as these obtained from experimental animals

do not encourage transplantation of foreign testis material to man as a theraupeutic measure.

REFERENCES

1. CUNNINGHAM, J. T. Hormones and Heredity. MacMillan Co., N. Y., 1921.
2. FUNK, C., and HARROW, B.: The male hormone. Proc. Society Expr. Biol. and Med., 1929, 26:325-326.
3. GALLAGHER, T. F., and KOCH, F. C.: The testicular hormone. Jour. Biol. Chem., 1929, 84:495-500.
4. HARRENSTEIN, R. J.: Über die funktion des scrotums und die behandlung der retentio testis beim Menschen. Zentrlbl. f. Chirur. 1928, No. 28:1734-1739.
5. HUNT, H. L.: The technic of gland transplantation. Endocrinology, 1928, 12:491-495.
6. MCGEE, L. C., JUHN, MARY, and DOMM, L. V.: The development of secondary sex characters in capons by injections of extracts of bull testes. Amer. Jour. Physiol., 1928, 87:406-435.
7. MOORE, CARL R.: (a) Properties of the gonads as controllers of somatic and physical characteristics. VI. Testicular reactions in experimental cryptorchidism. Amer. Jour. Anat., 1924, 34:269-316.
   (b) VIII. Heat application and testicular degeneration: the function of the scrotum. Amer. Jour. Anat., 1924, 34:337-358.
   (c) IX. Testis graft reactions in different environment (rats). Amer. Jour. Anat., 1926, 37:351-416.
   (d) Scrotal replacement of experimental cryptorchid testes and the recovery of spermatogenetic function (guinea pig). Biol. Bull., 1926, 41:112-128.
   (e) X. Spermatozoön activity and the testis hormone. Jour. Expr. Zool., 1928, 50:455-494.
   (b) XI. Hormone production in the normal testes, cryptorchid testes, and non-living testis grafts as indicated by the spermatozoön motility test. Biol. Bull., 1928, 55:339-357.
   (g) On the physiological effects of non-living testis grafts. Jour. A. M. A. (in press).
8. MOORE, CARL R., and GALLAGHER, T. F.: Seminal vesicle and prostate function as a testis hormone indicator; the electric ejaculation test. Amer. Jour. Anat., 1930, 45:39-70.
9. MOORE, CARL R., HUGHES, W., and GALLAGHER, T. F.: Rat seminal vesicle cytology as a testis hormone indicator and the prevention of castration changes by testis extract injection. Amer. Jour. Anat., 1930, 45:109-135.
10. MOORE, CARL R., and OSLUND, R.: Experiments on the sheep testis—cryptorchidism, vasectomy and scrotal insulation. Amer. Jour. Physiol., 1924, 67:595-607.
11. MOORE, CARL R., PRICE, D., and GALLAGHER, T. F.: Rat prostate cytology as a testis hormone indicator and the prevention of castration changes by testis extract injection. Amer. Jour. Anat., 45:71-107.
12. MOORE, CARL R., and QUICK, WM. J.: (a) The scrotum as a temperature regulator for the testes. Amer. Jour. Physiol., 1924, 68:70-79.
    (b) VII. Vasectomy in the rabbit. Amer. Jour. Anat., 1924, 34: 317-336.
13. OSLUND, R.: A study of vasectomy on rats and guinea pigs. Amer. Jour. Physiol., 1924, 67:422-443.
14. OSLUND, R.: Vasectomy on dogs. Amer. Jour. Physiol., 1924, 70:111-117.
15. YOUNG, WILLIAM C.: The influence of high temperature on the guinea pig testis: histological changes and effects on reproduction. Jour. Expr. Zool., 1927, 49.

DISCUSSION

Dr. William E. Lower (Cleveland): Clinically, we have tried out various methods of transplanting one ureter and at a later time the second, after the method of Coffey. We have not had a very large experience in using the catheter, but it has not turned out as successfully as we had hoped in all cases. Our best results have been obtained when we have transplanted first one ureter, and then later the second without using a catheter.

Even if infection does occur, clinically it is not always so serious a matter. It has been demonstrated that these patients go on and bear children, and to all intents and purposes have a fairly comfortable economic existence.

I want to take this occasion to express my personal appreciation of this very excellent report which Dr. Moore has presented. I think it is the most far-reaching research that has been brought forward in a long time, and has possibilities of great practical application. I think the society is very greatly indebted to him.

Dr. Roger C. Graves (Boston): I should like to add one case to Dr. Jeck's report, that of a woman who had had pain in the right flank for many years following nephrectomy. After eliminating everything else, it was apparent that this was another instance of painful ureteral stump. At operation I found that the upper end of the ureter, which was otherwise perfectly normal, had been tied in with the vascular pedicle at the time of the removal of the kidney. This fixed suspension in scar appeared to have provided the stimulus for persistent peristalsis with resulting pain.

Ureterectomy relieved the symptoms, and she has been free from her pain for several years.

Dr. C. E. Burford (St. Louis): I was interested in Dr. Jeck's paper. We have two types of cases in our experience with which we deal in two different manners with those ureteral stumps. I think we have had better success with the tuberculous ureters in not attempting too low a ligation, and in some of the large tuberculous ureters we have had very good success after ligating them, by simply sticking the hypodermic needle through the large ureteral wall and injecting pure phenol. We used to attempt to do it through the open ureteral end, which was rather hard to do without spilling some of it. We have found this

works very effectively, allowing the pure phenol to run down into the bladder, where it is diluted by solution in the bladder.

We have recently had a case of an enormous pus kidney with megalo-ureter in a very large patient. This man was a doctor. The condition followed a football injury many years ago. The kidney was of enormous size.

After rupturing the kidney in attempting to get it out, we had to deal with this very large ureter. It was dilated down to about 2 inches of the bladder. The man was very fat and we did not wish to make a long incision down to his pubic bone to remove this ureter, so we were able easily to strip it from the peritoneum by running the hand down from the loin incision to the point beyond where it was dilated, and by cutting it off without ligating it there, and putting down a drain. The wound has healed perfectly.

Dr. Hugh H. Young (Baltimore): Our society has indeed been given a great treat in this splendid paper by Dr. Moore. We have never had an important subject more fascinatingly presented, or a demonstration more beautifuly and succinctly given.

This work answers very effectively the age-long problem of why the undescended testes remain undeveloped. The positive demonstration of the rapidity with which the testis removed from the abdomen will go on to development furnishes experimental proof of clinical experience, and the demonstration of ill effects from even slight increase in temperature shows us the great danger of the use of heat as a therapeutic measure in inflammatory conditions of the epididymis. Certainly we will all be much more careful in the treatment of epididymitis not to apply heat in such form that it may injure the testes. It is an amazing paper—and will, I feel sure, lead to other experimental and clinical work, the results of which, I hope, will be to add much to urological literature.

Dr. Vincent J. O'Conor (Chicago): Dr. Moore has been kind enough to keep me acquainted with his work for the last several years. I have been especially interested in it in regard to the effect that diathermy had on the testicle. When he first gave us his work several years ago, we became very much excited over the fact that we used diathermy quite frequently in young males suffering from gonorrheal epididymitis, and naturally

wished to find out as nearly as possible how much possible sterility might have been caused from the induced heat.

I went back, after his first communication, at least the first one that I knew of, and traced thirty-three patients, of whom twenty-seven gave data that seemed fairly accurate, taking only the bilateral epididymitis cases in which diathermy had been passed through both testes. Nine of the twenty-seven solved the problem by stating that they had married and had had children. Four of the others were examined, and after a certain amount of persuasion they revealed specimens which could be examined, and of those four, three had active motile sperm; the fourth had sperm which were non-motile, but the test was not satisfactory.

Shortly after the first report, an unusual instance came into my hands that gave me a chance to verify absolutely from the human point of view what Dr. Moore has stated with regard to his experimental work. A man about forty years of age had a bilateral vas ligation for purposes of sterility ten years before. He had been checked several times during that time and no sperm were found.

Two years before I saw him he had had a successful left vas anastomosis, with subsequent pregnancy of his wife and with demonstrable normal sperm in the ejaculated specimen. Here was an instance of an individual who was known to have only one patent vas, and, having completed his family requirements, on my suggestion offered himself as an experimental human animal.

The first experiment that we used on this particular man was the one-hour induction of tolerance amount of heat from a scrotal electrode on alternate days for three one-hour periods. The result was an immediate lack of sperm, and there was a complete absence of sperm in ejaculated specimens taken on an average of every fifth day, until the ninth week. On the ninth week rather atypical sperm began to appear. By the end of the eleventh week there were many sperm; there were many of them non-motile; many of them were getting motility. By the end of the fifteenth week the sperm had returned to practically normal visible appearance.

The same man six months later allowed me to repeat the experiment, being previously checked as having normal motile sperm in large quantity, and one heat induction of thirty minutes

to tolerance amount of heat caused absolute amotility of the sperm, caused a marked decrease in the number of the sperm, and recovery took place apparently within about ten days.

Apparently from the clinical application of this practical experiment, we produce either a temporary sterility with heat induced into the body of the testes, the epididymis, and of course that can be carried to the point where there would be a permanent destruction, but in an individual treated for one hour, three days out of six, which is much more frequent and a much longer application than the average clinical treatment, the sperm appeared after the fifteenth week to be normal.

I think Dr. Moore has pointed out very definitely the dangers of the overuse of heat in the testes and the possibilities of sterilization, but in clinical application I feel from the small amount of human material studied that the change is somewhat similar to the changes due to X-ray, that is, there is a complete temporary arrest, with return in most instances after a period of time.

I want to thank Dr. Moore for this work.

CLINICAL EVALUATION OF BLOOD INDICAN TESTS IN CASES OF URINARY RETENTION

PROF. DR. A. VON LICHTENBERG

Berlin, Germany

Mr. President and members of the Society:

When I had the honor last year of being at your meeting, I did not believe that a similar opportunity would be afforded me so soon again. My pleasure is therefore all the greater in attending your meeting this year, and in having the privilege of reading a paper.

Functional kidney diagnosis, which caused great advancement in urological surgery, does not possess today its original importance. Refined methods, such as Ambard's coefficient, the S. U. A. test of Rehn, and the iodin test of Pregl, are not suited for general or clinical practice, as simpler tests perform the same functions just as satisfactorily. The clinic of surgical kidney diseases rests more on the viewpoint of anatomy and dynamics, than on the viewpoint of functional examination. Functional tests have their main importance in double sided kidney disease and are an indispensable aid in estimating functional improvement.

It is otherwise, however, in cases of obstruction of the lower urinary tract, in the vesical and urethral forms of urinary constipation. In these cases the estimation of kidney damage is of paramount importance. Prognosis, indications and operative surety depend for the most part on kidney function. The great experience which you have in urology in America has caused you to recognize early the important relationship between prostatic disease and the diseases of the heart, blood vessels and tissues. Many papers from your meetings this year deal with this question and I am glad that I have chosen a subject which touches on this relationship.

In spite of great experience and profound studies, there is still uncertainty in the judgment of kidney function in prostatic hypertrophy. Even those who operate in only the so-called good cases experience disagreeable surprises, which are not due to

surgical causes. This experience is more frequent with those whose operative indications include a wider field.

In 1910, I instinctively chose a two-stage prostatic operation in certain cases. This by no means solves all difficulties, though in many cases increasing the margin of safety. The help we need can not come from an improvement of operative procedures, but from an improvement of preoperative study. Even a punch operation or a catheterization might, under certain circumstances, lead to a fatality.

The customary kidney functional tests, either individually or in combination with each other, give important information concerning the kidney status. We should determine the true value of these tests in general and we should evaluate the tests individually with each other.

The dilution and concentration test of Volhard, the estimation of rest nitrogen in the blood and indigocarmin excretion and blood pressure estimations are the usual clinical tests by us in cases of urinary obstruction. Salt excretion is not estimated, as it suffers no impairment. In certain cases, however, these tests deny us important information. Urology should use the methods of internal medicine in studying the heart and kidneys. Greater operative surety can be obtained only in such study.

In examining the heart and blood vessels in cases of prostatic hypertrophy one should use, besides the usual physical examination and blood pressure estimations, the orthodiagraph and electrocardiograph, about which my pupil, Dr. Hughes, will report. The viscosity of the blood and the sedimentation and clotting time should be determined also. From the urological interpretation of these examinations we might obtain important information.

The blood vessels and tissues play an important part in the determination of renal balance. We, therefore, should choose those elimination and retention tests which, through their investigation of tissue and vessel factors, would give a clearer and more accurate picture of kidney function.

As elimination tests, the dilution and concentration test and indigocarmin excretion can give us only general information. In the water test, we have sufficient kidney function if twelve points separate the highest dilution and lowest concentration. Whether we have better kidney function if these twelve points

separate higher concentrations or lower concentrations is not yet known. The variability of this test, probably due to extrarenal factors, however, is evidenced in the results after bladder decompression. Here the result of the water test indicates a functional condition worse than actually exists.

In prostatic cases we prefer estimating the indigocarmin after subcutaneous or intramuscular injection, as it orients us better concerning the entire complex of elimination. Appearance of the dye seven to ten minutes after subcutaneous or intramuscular injection is prognostically good; appearance within fifteen minutes is prognostically favorable. Difference in appearance of the dye following subcutaneous or intramuscular and intravenous injections might give us information concerning extrarenal factors.

These two elimination tests suffice generally and in their accurate interpretation one need only consider the influence of extrarenal factors. But such is not the case with the customary retention-tests—the estimation of non-protein nitrogen and urea in the blood. The non-protein nitrogen is 75 per cent urea and the remaining portion consists of uric acid, ammonia, amino and other nitrogenous bodies. The high normal limit of blood non-protein nitrogen, while not fixed exactly, is usually accepted as 40 mg. per 100 c.c. In using the non-protein nitrogen test one can fall into great error, when the nitrogenous substances are retained in the tissues, and so are not increased in amount in the blood. In these cases we can have a normal blood picture even though there is greatly disturbed kidney function. An increase of non-protein nitrogen in the blood, however, always indicates kidney damage.

We also know from the investigations of Burgers and Graham that there is an increase of non-protein nitrogen in the blood and urine after all operative procedures. This postoperative azotemia is a consequence of endogenous protein disintegration and is not due to a failure of kidney elimination. It is apparent that, with this source of error, non-protein nitrogen determinations of the blood do not indicate accurate postoperative prognosis. And, preoperatively, we may have kidney damage without an increase in the non-protein nitrogen of the blood.

Becher has pointed out that in acute nephritis, in which real uremia seldom occurs, the elimination of the aromatic bodies,

tyrosine and tryptophane, from the blood is not impaired, whereas in the chronic nephropathic the aromatic bodies accumulate in the blood stream. This fact supports the viewpoint that uremia is an intoxication caused by the aromatic bodies from intestinal putrefaction.

Bar has shown that an increase of indican in the blood is pathognomonic of kidney disturbance.

My pupil, Dr. Widenhorn, investigated the relation of blood phenol to prostatic retention. The tests used were the xanthoprotein reaction (Becker) in blood, the urochromogen reaction (Weiss) in blood and urine and the cholin test (Becker) in urine.

We wished to learn the relationship between high non-protein nitrogen in the blood and the retention of protein-disintegrating substances (oxyamino acid and phenol) which through the xanthoprotein reaction can be estimated quantitatively. We also wished to learn the relation of these bodies to blood pressure elevation in prostatic hypertrophy, as adrenalin is a derivative of two-valent phenol, and urea (carbamide of HCO_3) can also produce an elevation of blood pressure.

In prostatic retention, however, we found that the xanthoprotein in blood was normal, even when the non-protein nitrogen was elevated. The urochromogen and cholin tests gave us no usable information. In prostatic carcinoma, however, an extraordinary amount of xanthoprotein was a constant blood finding and this fact may be used in differential diagnosis.

We soon realized that the most reliable retention test in prostatic hypertrophy was the estimation of blood indican. One generally accepts 0.09 mg. per cent as the upper normal limit of indican in the blood. An increase of 0.01 mg. per cent of indican indicates kidney damage. The Toly determination works very satisfactorily. Indican is not distributed in appreciable amount in the tissues, and, in kidney insufficiency, always increases in the blood. The sources of error in the indican test, severe intestinal disease and uncompensated heart disease are easily recognizable.

Lichtenstein of Vienna first used the indican blood test in prostatic retention. Following the Becher system we investigated the test and have been using it for the past four years. I

submit to your judgment the results in a series of 101 consecutive cases of the past year.

From this grouping it can be seen that in 101 cases indican was increased in forty-eight where non-protein nitrogen was over forty in only twenty cases. If we regard up to 50 mg. as a normal non-protein nitrogen figure, there remain only eleven cases, or less than one-fourth the number of positive indican cases, in which the non-protein nitrogen figure indicated kidney damage.

Of the thirty-four cases in which blood indican was between 0.1 and 0.15 mg. per cent, indigocarmin excretion was delayed beyond fifteen minutes in only five cases, and the water test showed a difference of less than twelve points in only eleven cases. There is a closer agreement in those cases where the blood indican was above 0.16 mg. per cent. In fourteen cases, the indigocarmin excretion was delayed beyond fifteen minutes in nine, and the water test showed less than twelve points in thirteen cases.

Of the fifty-three cases with normal blood indican, indigocarmin excretion was delayed beyond fifteen minutes in seven cases and the water test indicated kidney damage in ten cases.

It can be seen that the great advantage of the indican test is in those cases in which the indican figure is between 0.1 and 0.15 mg. per cent., as approximately but one-seventh of these cases showed delayed indigocarmin excretion and only one-third of the cases showed an impaired water test.

In conclusion, I would point out that the estimation of blood indican appears to be the most sensitive retention test of impaired kidney function in cases of prostatic retention.

FUNCTIONAL KIDNEY TESTS

A NEW PHTHALEINOMETER AND CHART FOR RECORDING TESTS

HUGH H. YOUNG, M.D.

From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital, Baltimore, Maryland

My interest in functional tests for the kidney was first aroused while I was a student in Casper's clinic in 1900. Casper and Richter had just brought out their book on the phloridzin test, which excited great interest as being the most promising effort to determine by chemical means the function of the kidneys. As a check, they were using in the clinic the specific gravity tests, and particularly the "total specific gravity," which was obtained by multiplying the amount of urine excreted in twenty-four hours by the specific gravity.

Returning home I applied these tests to cases in which the urine was obtained by a ureteral catheter, and in general urological cases, checking them by obtaining the freezing point, and also by using indigocarmin, and Ambard's constant, which came out later. About this time blood chemistry in renal cases was being stressed more and more. Although these methods were practical, and very valuable in the comparative study of the urine obtained by ureteral catheterization, they were not satisfactory in that most important series of cases in which the kidney is impaired by back pressure from prostatic hypertrophy. In these we needed methods of determining when it would be safe to operate.

Some years before, I had noted the wonderful improvement which came from suprapubic drainage in cases of complete retention with chronic uremia, but I had also seen cases in which immediate suprapubic drainage, or even the insertion of a catheter, was followed by suppression of urine, and death. No method was at hand to tell me when these patients, who were improving on drainage, could be subjected to operation with safety.

DISCOVERY OF THE PHENOLSULPHONEPHTHALEIN TEST

In 1884 Remsen, professor of chemistry at the Johns Hopkins University, described phenolsulphonephthalein,[2] but nothing further was done with this drug until Abel, testing its physiological properties, showed that over 95 per cent of the drug was eliminated through the kidneys and with remarkable rapidity. The drug was again put aside as being of no particular value until 1909, when Abel and Rowntree[1] attempted to see whether phenolsulphonephthalein would be eliminated in a different way in a case in which nephritis had been produced experimentally.

I happened to be present one day when Rowntree showed a dog in which the right kidney had been exposed, the artery injected with uranium nitrate, and the ureter cut and brought outside, so that the urine could be obtained separately. After an injection of phenolsulphonephthalein, Rowntree demonstrated that a larger percentage of the drug was eliminated through this kidney, upon which he had operated, and thought he had produced experimental nephritis. I told him that I had a case in my wards (B. U. I. 1932†) which presented a situation similar to that which he had produced in his dog, in that the urine from the right kidney, the ureter of which was blocked by a stone, escaped entirely through a postoperative fistula in the loin, whereas the urine from the left kidney alone passed into the bladder. We tried out the drug in this case, but it was shown that instead of the diseased kidney eliminating more of the drug than the healthy kidney, much less was eliminated. This observation was confirmed by numerous other clinical tests in cases of prostatic hypertrophy.

Geraghty then associated himself with Rowntree, and together they investigated the drug in hundreds of patients in my wards, and out-patient dispensary, and finally presented the epoch-making report,[3] in which the great value of phenolsulphonephthalein was demonstrated, and its technical use perfected. In a very short time it was shown that we had, in the phenolsulphonephthalein functional test, a most valuable index of the condition of these back pressure kidneys, the rapidity with which they improved on drainage, and when they were sufficiently improved to withstand prostatectomy.

†For full details in regard to this case, see Young's Practice of Urology, vol. i, p. 48. (W. B. Saunders Company, Philadelphia.)

About the same time an increased interest in blood chemistry showed us that the urea and non-protein nitrogen determinations would give us a splendid check on the phenolsulphonephthalein test. We then demonstrated a remarkable inverse parallelism which occurs in these tests, and that this parallelism continued as the cases improved, the phthalein output gradually increasing, and the blood urea decreasing. The use of these tests has made prostatic surgery far more accurate, and has given us a most valuable method for evaluating the progress of the case.

As a result of extensive studies on animals and human beings, Rowntree and Geraghty published the curve of elimination shown

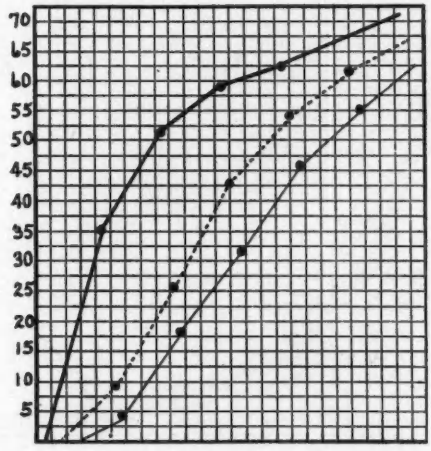


Fig. 1. Curve of elimination of phthalein from the kidney (Rowntree and Geraghty).

in Figure 1. This curve, however, was of no practical use in clinical work. Rowntree and Geraghty advised a technic in which the appearance time is obtained, and the amount of phthalein excreted for the first and second hours after its appearance. Where a catheter was not used, they recommended that two hours and ten minutes be used for the collection.

As the years went by, the standard technic advised by Rowntree and Geraghty was used virtually without question throughout the world. But with the progress of time it came to be

more and more evident that such a technic could not give us the detailed information in regard to the kidney function which we should possess. We showed that in a great number of cases the amount of phthalein excreted in two hours and ten minutes would often be the same in kidneys that were normal and in those that were definitely impaired. If a catheter were used in such cases the appearance time was generally found to be delayed, and the amount of urine put out during the first hour

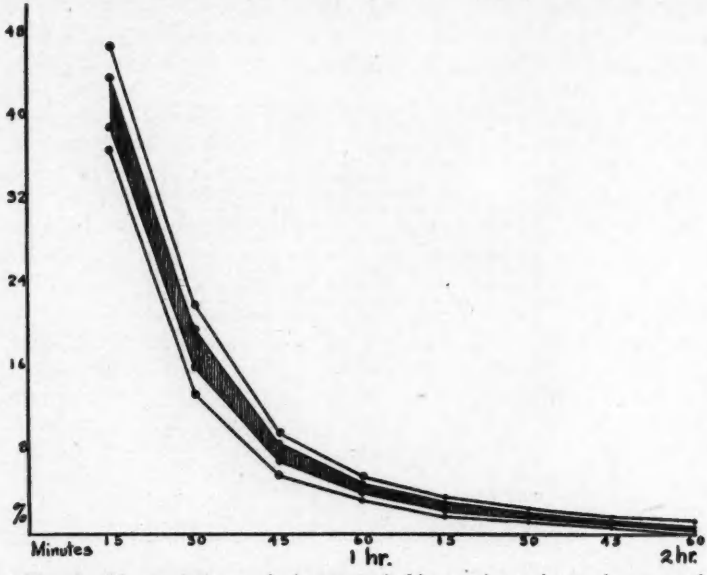


Fig. 2. The variations of the normal fifteen-minute interval curve of phthalein elimination as determined by forty-four tests on twenty-three normal individuals (Shaw).

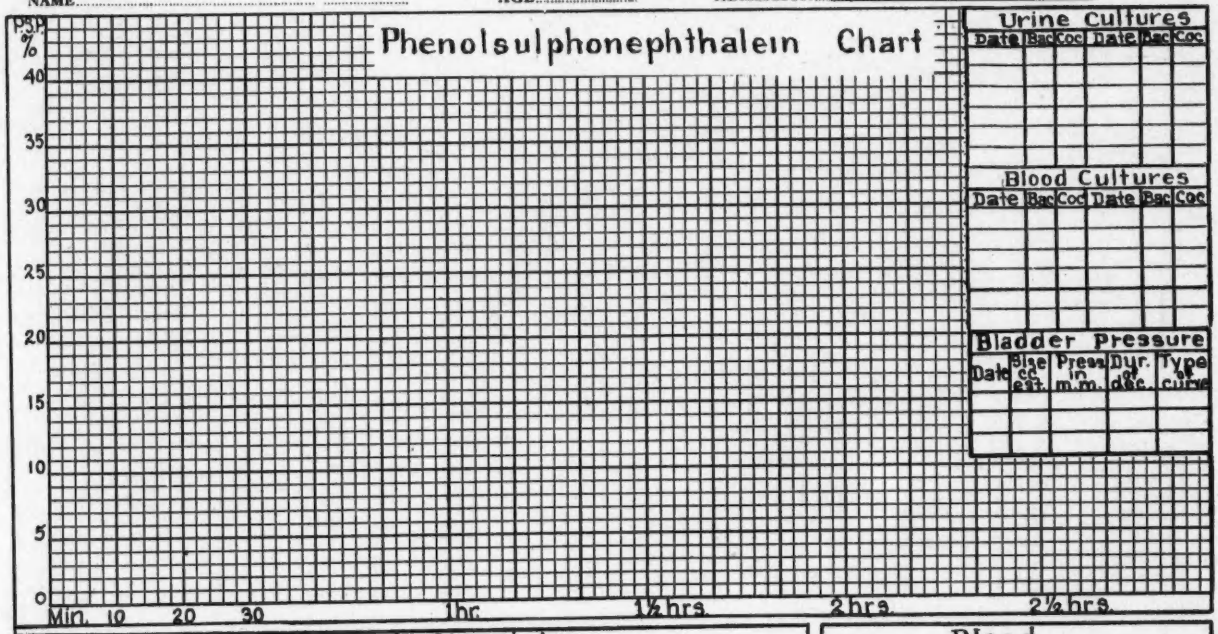
much less in the case with impaired kidneys than that with normal kidneys. Even with the use of a catheter and the determination not only of the appearance time, but also the separate estimations at the end of one and two hours after appearance, the test was sometimes deceptive.

In 1924 Shaw,[4] then resident urologist at Johns Hopkins Hospital, undertook, at my suggestion, to make a more comprehensive study of the phthalein test, and, as a result of a great

Y-D CHART NO. 1

LABORATORY CHART

NAME..... AGE..... ADMISSION..... HIST. NO.....



Urine Cultures

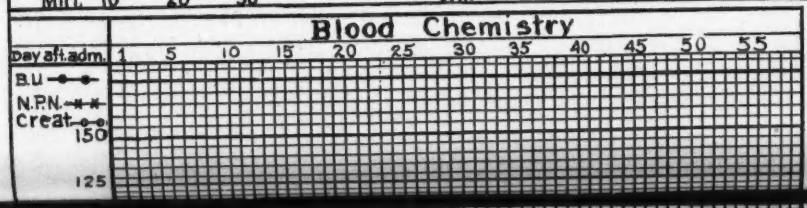
Date	Bac	Coc	Date	Bac	Coc

Blood Cultures

Date	Bac	Coc	Date	Bac	Coc

Bladder Pressure

Date	Size cc. est.	Press. in m.m.	Dur. of obs.	Type of curve



Blood

Date	Hgb.	R.B.C.	W.B.C.

Blood Grouping

Date	Gr.	Date	Gr.

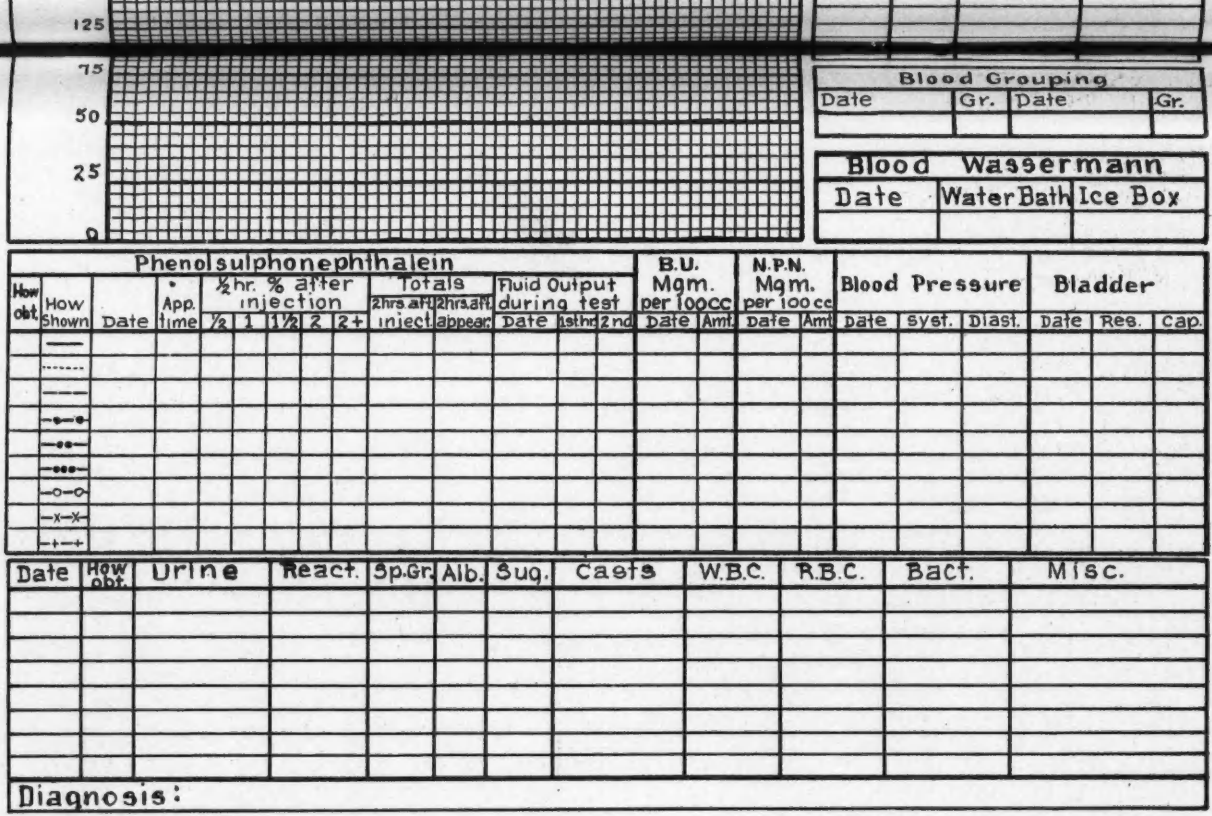


Fig. 4. General clinical urological chart of laboratory findings (Young and Didusch, No. 1).

number of investigations in human cases, published the curve of elimination, as shown in Figure 2. This curve, as it may be seen, was based on phthalein estimations taken every fifteen minutes after injection. Shaw's studies, as exemplified by this curve, demonstrated at once the great importance of more frequent estimations than the usual two hours, or even with two one-hour intervals, and explained the discrepancies which we had encountered where the total output in two hours had alone been used for determining the kidney value.

Shaw's curve was not practical for clinical uses. After a good deal of experimentation with charts of different types, I

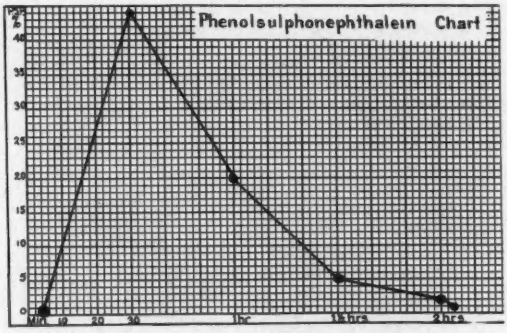


Fig. 3. Normal curve of phthalein excretion (Young).

finally introduced the charting method shown in Figure 3. As seen here the appearance time is noted on the chart and the phenolsulphonephthalein estimations are determined every half-hour after injection, and in addition to that for a period equal to the appearance time after the fourth half-hour. Thus we have, in one chart, recorded the curve of phthalein output for two hours after injection, and also for two hours after appearance. The line running from the appearance time to the first half-hour gave us surprising results and valuable information. It was soon evident that we could determine from this line alone, by its height and steepness, fairly accurately, the condition of the kidney, and when taken with the lines connecting the other half-hour estimations, it gave us a curve by means of which

the operator could at a glance determine the situation as to renal impairment. In order to assemble all the valuable data on one chart, we finally determined upon the chart shown in Figure 4. A glance at this chart will show the various laboratory

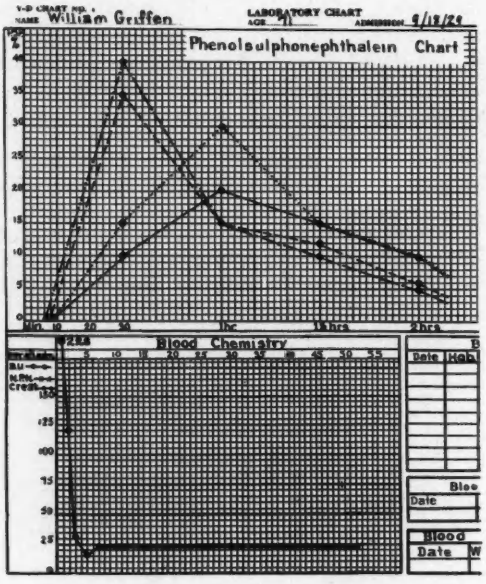


Fig. 5. B. U. I. 19182. Acute uremia (blood urea 230) in a case of obstruction. Residual urine 1,000 c.c. Prostatectomy successful.

and clinical data which may be recorded, all of which are of value in the clinical estimation of the condition of the patient, and his improvement under treatment.

Figure 5 shows the phenolsulphonephthalein and blood urea estimations in a case of prostatic obstruction with residual urine of 1,000 c.c. (Patient was in acute retention; bladder distended to umbilicus.) The patient was admitted in acute uremia, the blood urea being 228 mg. per 100 c.c. The phenosulphonephthalein test showed an appearance time of eight minutes, but the curve of elimination was bad, 10 per cent the first half-hour, 20 per cent the second, 15 per cent the third, and 10 per cent the

fourth. Under continuous catheter drainage the uremia rapidly disappeared, and within five days the blood urea was normal, and the phthalein test had begun to improve.† After thirty

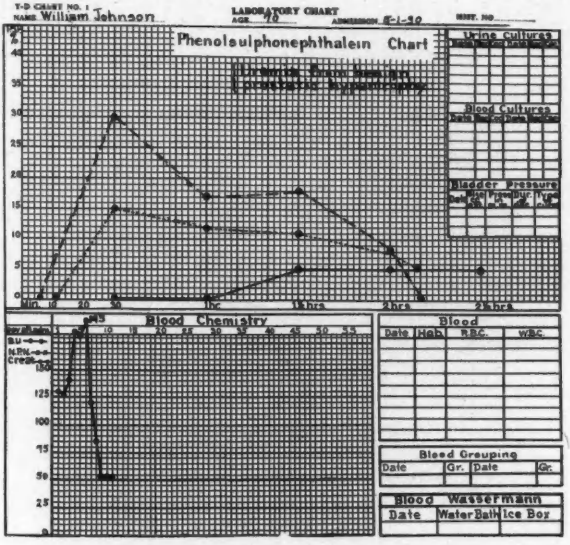


Fig. 6. B. U. I. 19586. Chronic uremia due to prostatic hypertrophy. Marked improvement with catheter drainage. Prostatectomy successful.

days the initial line (first half-hour) was excellent. The amount put out in the first half-hour was 40 per cent, and the curve was almost normal. The patient was then subjected to perineal prostatectomy successfully.

The accompanying charts indicate the value of this method of recording the clinical findings and the accurate inverse parallelism by the phenolsulphonephthalein and the blood urea determinations.

In Figure 6, that of a case of prostatic hypertrophy with chronic uremia from back pressure, on entrance the blood urea was 130 mg. per 100 c.c., and at the end of one half-hour the first trace of phthalein appeared in the urine. During the next half-hour there

†In all these charts the successive phthaleins are charted with dotted or broken lines as indicated in the tabulated record.

was still only a trace of phthalein present. During the following three half-hour periods only 5 per cent was eliminated each time, the total being 15 per cent in two hours and thirty minutes after injection. Under catheter drainage there was for a period an increase in the blood urea which reached on the sixth day 195 mg. per 100 c.c., but after that under catheter drainage it rapidly dropped to normal, and remained so up to the time of operation. During

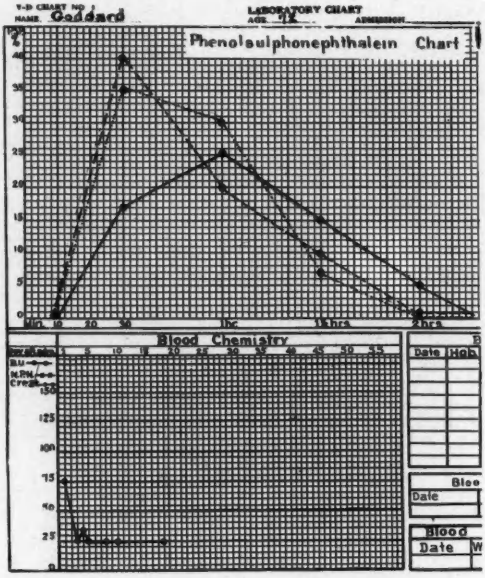


Fig. 7. B. U. I. 19305. Marked renal impairment with great improvement under catheter drainage Prostatectomy successful.

the same period the phthalein test showed gradual improvement, as seen in the successive curves, and finally, before operation, the appearance time, which had previously been one half-hour, had dropped to six minutes, the amount put out in the first half-hour after injection was 30 per cent, and the total curve was an excellent one.

The next case (Fig. 7) with much residual urine had blood urea of 75, and a phthalein curve which showed considerable impairment (appearance time 10 minutes, half-hour eliminations 17, 25, 15 and 3). With catheter drainage the blood urea dropped to

normal in three days, and the successive phthalein curves showed rapid improvement. Finally a normal curve with a fine, steep initial line, 40 per cent output the first half-hour, and a good general curve, was secured.

In the next case (Fig. 8), that of a man with chronic retention of urine and extremely bad phthalein curve on admission, the appearance time was 45 minutes, output first hour, 1 per cent; third

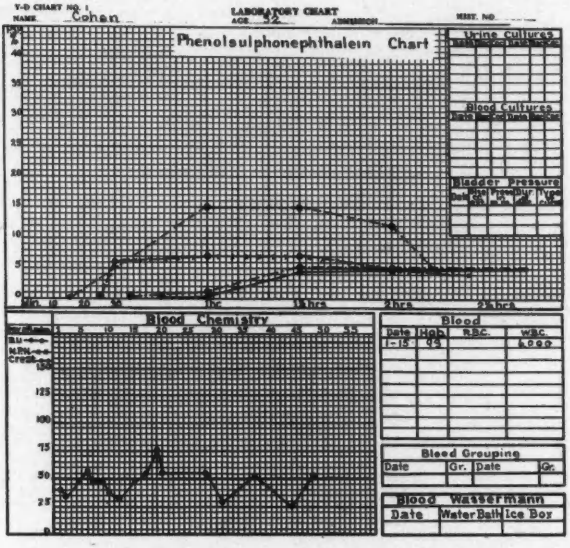


Fig. 8. B. U. I. 19254. Severe renal impairment; uremia due to prostatic obstruction. Marked improvement under catheter drainage. Prostatectomy successful.

half-hour, 5 per cent; fourth, fifth and sixth half-hours, 5 per cent each. The total eliminated in two hours after the injection was 11 per cent; total eliminated two hours after appearance 16 per cent. Even though the kidney function was very bad, the blood urea was not found to be on admission increased, 40 mg. per 100 c.c. Under catheter drainage the phthalein excretion remained the same for several days, and then began to improve, as shown in the chart. The appearance time had dropped to twenty-five minutes, and the amount excreted in two hours after injection was 28 per cent. A cystogram was then taken, and showed reflux and marked dilatation of the ureters. Ureteral catheterization was carried out. Following this the patient became much worse, the blood urea rose to 75, the phthalein

went back to the condition on admission. After a long period of catheter drainage the blood urea finally came down to normal, and the phthalein curve had improved greatly (appearance time fifteen minutes, half-hour eliminations 5, 15 and 12, total 32 per cent). Perineal prostatectomy was then carried out under caudal anesthesia, and after a stormy convalescence the patient recovered, and

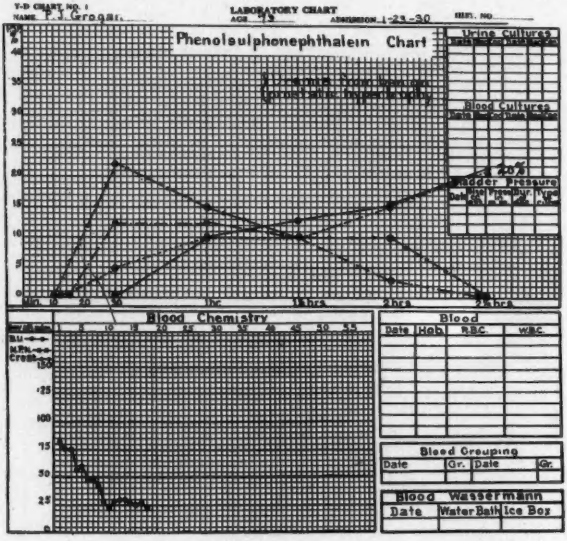


Fig. 9. B. U. I. 19275. Marked renal impairment; uremia due to prostatic obstruction. Great improvement under catheter drainage. Prostatectomy successful.

left with a distinctly improved condition of the kidneys. Although it is evident that chronic nephritis was present, the blood urea was normal.

This case is a splendid example of the great value of comparative phthaleins and blood urea tests, and demonstrates again the fact we have often pointed out, that even with marked impairment of the kidneys the blood chemistry may show no evidence of it.

Another example of the value of these charts, and the remarkable inverse parallelism of the blood urea and phthalein curve, is shown in Figure 9.

As seen here, there was on admission a high blood urea and a poor phthalein curve, but on continuous catheter drainage a progressive diminution of blood urea which reached normal on the tenth

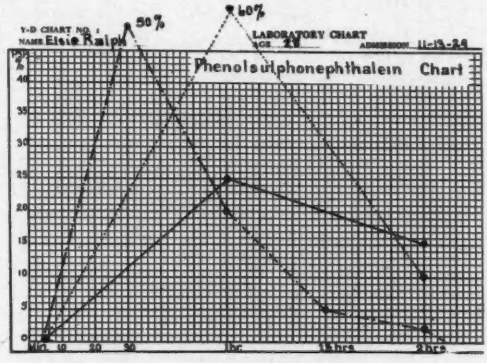


Fig. 10. Acute nephritis. Marked renal impairment. Rapid improvement after drainage of abscess of antrum.

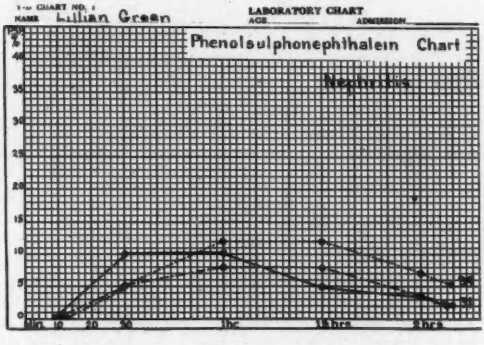


Fig. 11. Chronic nephritis. Phthalein curve slowly getting worse. Death from uremia.

day, and in the meantime a gradual increase in the phthalein output and improvement in the curve, until finally an almost normal curve was reached (appearance time ten minutes, output first hour 23 per cent), as shown in the chart. Here, again, prostatectomy was carried out successfully.

This chart may be used in chronic nephritis to demonstrate conditions present under treatment.

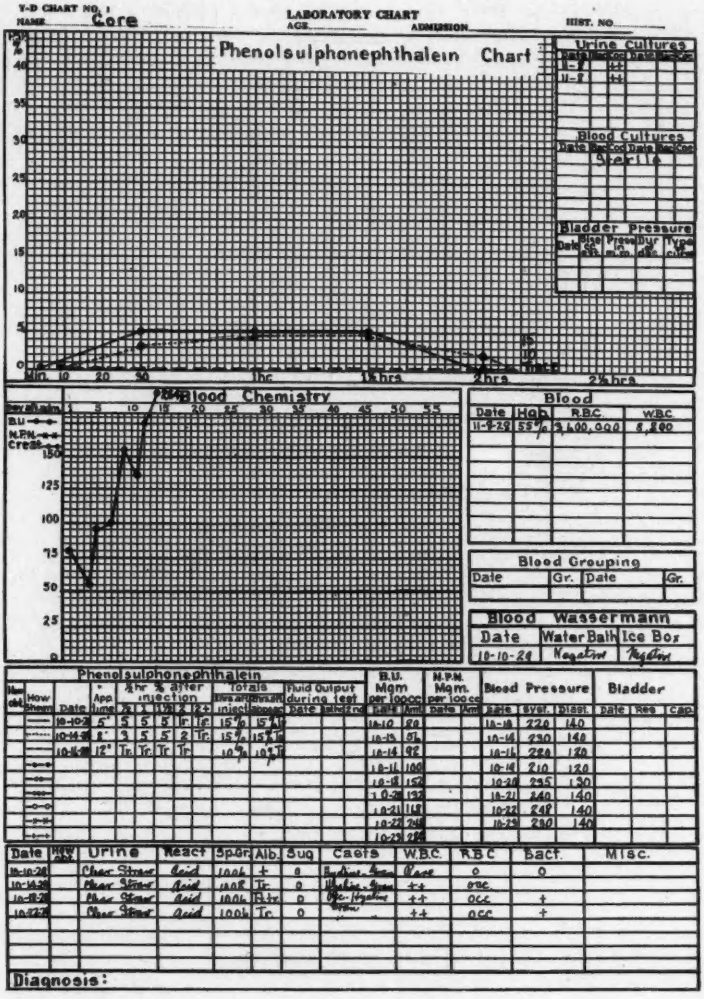


Fig. 12. Chronic uremia due to nephritis. Renal function rapidly decreasing. Blood urea increasing. Death.

In the next case (Fig. 10), the phthalein curve on admission was bad. The appearance time was two minutes, the output the first hour, 25 per cent; second hour, 15 per cent; total 40 per cent. The non-protein nitrogen in the blood was 25. An abscess of the

Fig. 13. A new Young-Elvers phthaleinometer with permanent color discs accurately graduated to read increasing percentages of phthalein of specimen which is carried in square ground glass test-tube (a). If the specimen has a strong urinary color, accurate matching may be obtained by placing an equally diluted specimen of urine in the tube (b). The lens to magnify the reading of the parallel planes of color is not shown. The tube which carries the stem of the lens is shown beneath the reading glasses.

antrum was opened and drained. This was followed by a rapid improvement in the urine, disappearance of albumin and casts, and at the same time, progressive improvement in the phthalein curves,

as shown on the chart. The blood chemistry here showed nothing of value; in fact, was deceptive, as the non-protein nitrogen was normal.

In the next case (Fig. 11), one of chronic nephritis, which did not improve under treatment, there was a continuously high non-protein nitrogen, 50 mg. per 100 c.c. The first phthalein estimation was the best, the appearance time being ten minutes, the successive half-hours being 10, 10, 5 and 5 per cent. The patient went

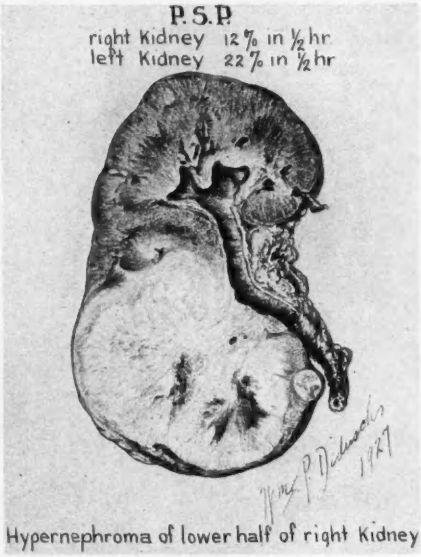


Fig. 14. B. U. I. 16510. Long section of kidney showing separated phthalein excretion.

suddenly down hill, the second and third weekly phthaleins showing a steady decline, and eventually died of uremia.

In the next case (Fig. 12), there was a chronic nephritis present, and a poor phthalein curve on the first examination as shown on the chart. The blood urea showed only a slight rise and on the fourth day was normal. The phthalein chart taken at that time showed a longer appearance time, and a lessened output, and later blood urea estimations showed a rapid increase. At the same time the phthalein test showed only a trace of elimination at the end of two hours, the blood urea in the meantime having reached 284. The patient soon died in uremia. The remainder of this

chart, in which the actual figures were recorded, shows that the urinalyses varied very little during this important period. The specific gravity remained about the same, there being only a trace of albumin and only a few casts. The blood pressure, however,

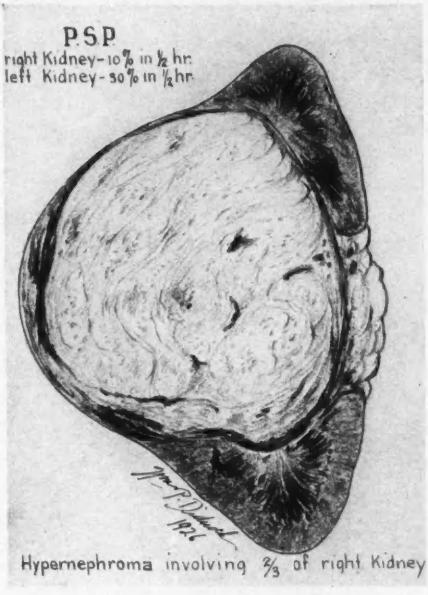


Fig. 15. B. U. I. 11993. Long section of kidney showing separated phthalein excretion.

remained very high, especially the diastolic, which was always around 140, and indicated the gravity of the situation.

In the first estimations of the phthalein output made by Rowntree and Geraghty, the duBoscq colorimeter was used. After that, cheaper and simpler instruments were devised and finally Dunning produced his simple apparatus, which has been very largely employed the world over. We have never felt, however, that this instrument had the requisite accuracy for highly scientific work, and have recently constructed a new colorimeter with a rotating wheel which contains graduated discs of colored glass, which accurately duplicate the phthalein color. By means of

this apparatus (Fig. 13), the estimation of the phthalein output is made more rapidly and accurately than by any other method we have previously employed. It is hereby recommended for general use where rapid and accurate estimations are desired, such as are necessary in cases of prostatic surgery.

ACCURACY OF THE PHTHALEIN TEST

This has been proved by the hundreds of clinical estimations which have been made, but in order to give more concrete evidence, I would like herewith to record the phthalein estimations

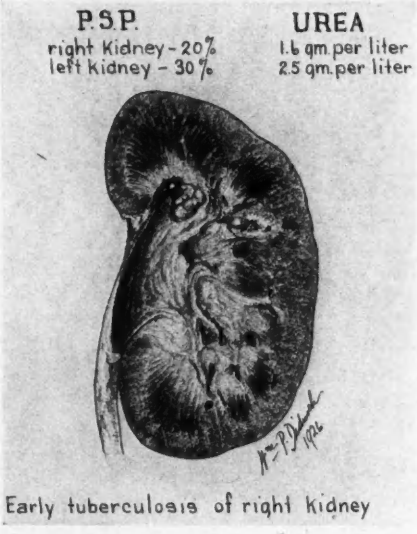


Fig. 16. B. U. I. 3515. Long section of kidney showing separated phthalein excretion.

in operative cases in which nephrectomy was carried out.

As shown in Figure 14, a case in which right nephrectomy was carried out for hypernephroma, examination of the specimen showed that the lower half of the kidney was involved in the tumor, and the upper one-half was normal. The phthalein test in this case was 12 per cent for the right side, and 22 per cent for the other.

In the next case (Fig. 15), there was a hypernephroma involving about two-thirds of the right kidney. The phthalein test here showed 10 per cent from this side, and 30 per cent from the other.

In the next case (Fig. 16), there was an early tuberculosis of the right kidney. The phthalein test from the right side showed an output of 20 per cent, and the left kidney was normal (30 per cent).

In the next case (Fig. 17), there was a tumor which involved about one-half of the right kidney. The phthalein test showed 10

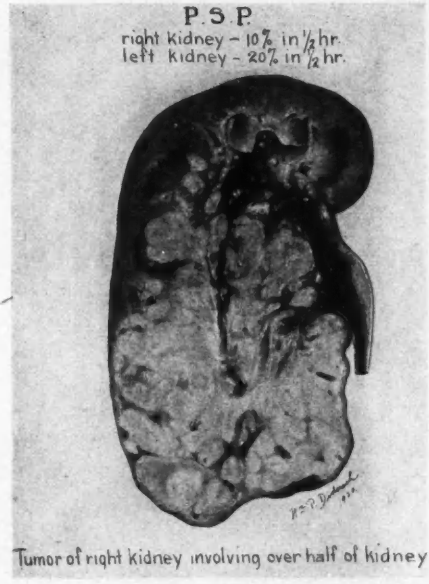


Fig. 17. B. U. I. 8600. Long section of kidney showing separated phthalein excretion.

per cent from this side ,and 20 per cent from the other in half-hour intervals.

In the next case (Fig. 18), a very extensive tuberculosis of the right kidney, with hydronephrosis and stones, there was a mere trace of phthalein excreted in one half-hour, while from the opposite side 15 per cent was excreted.

In the next case (Fig. 19), there was a very extensive tuberculosis, which had almost completely destroyed the right kidney. There was no phthalein excreted in one half-hour from this side, whereas the opposite kidney excreted 16 per cent.

If space permitted, I could furnish many more illustrations to demonstrate the great accuracy of the phthalein test, but this is hardly necessary. The phthalein test has now been used in my clinic for over twenty years. As a result of thousands of experiences with this test, and a very careful clinical study of many hundreds of cases, I have no hesitation in saying that the

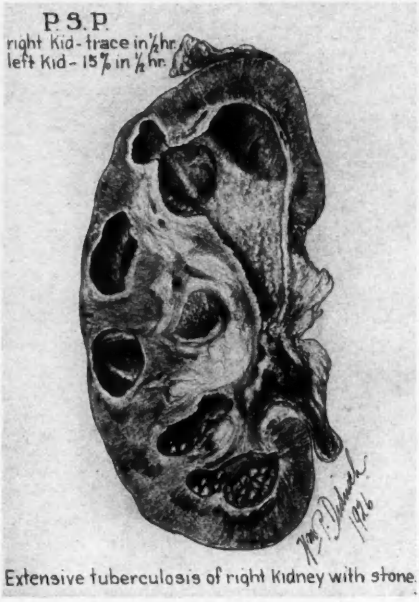


Fig. 18. B. U. I. 5106. Long section of kidney showing separated phthalein excretion.

test has proved to be extremely accurate in almost all cases; that with the progress of time and improvement in technic, and with the development of blood chemistry, more accurate studies and more sure determinations of the actual conditions present have been possible. With the development of the new methods of charting, which I have shown here, and the estimation of the renal function at half-hour intervals, we have developed a quick method, by which the clinician may know at a glance the

renal condition, watch the improvement from day to day, and finally determine when it is safe to carry out a major operation. These charts not only show beautifully the improvement in the

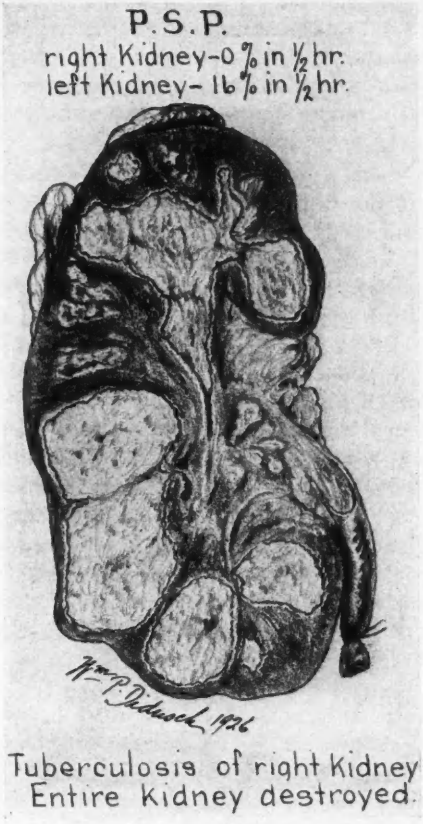


Fig. 19. B. U. I. 14477. Long section of kidney showing separated phthalein excretion.

appearance time and the initial excretion line, the gradual approximation towards the normal excretion curve for two hours, but also in uremic cases the beautiful inverse parallelism between the blood chemistry and the phthalein test. Provision has also

been made on this chart for recording many other clinical and laboratory estimations, which makes it, in our opinion, a valuable addition to the clinical study of urinary cases. Although we still value highly the specific gravity test, the necessity of giving large amounts of water in cases of impaired renal function robs it of its accuracy. It is my opinion that it offers in prostatic cases no help in the determination of the actual conditions present; particularly in the improvement of the case towards safe operability.

The fairly general use of indigocarmin to determine renal function is, in prostatic cases, inexplicable, because, so far as accuracy is concerned, it is not to be compared with the phthalein test. Only 25 per cent of the indigocarmin injected is eliminated through the kidneys. It appears much more slowly and many hours may elapse before the total elimination through the kidneys is completed, whereas in normal kidneys 75 per cent or more of the phthalein injected is eliminated within the first two hours. I wish, therefore, to protest against the use of indigocarmin as a renal function test, except where ureteral catheterization is difficult or impossible. Then by observing the time of appearance of indigocarmin and the relative intensity of the color, information of some value may be obtained; but as a function test, phenosulphonephthalein is certainly infinitely more accurate, and, when combined with blood chemistry, gives a very splendid means of determining the actual condition of the kidneys, and the progress of the case. As mentioned before, blood chemistry shows renal impairment only in later stages, whereas the phthalein test gives an early indication of even slight impairment, and warns the clinician, by the delay in appearance time and the poor elimination, of impairment long before the blood chemistry gives any indication of renal disease.

Uroselectan, as we have shown elsewhere,[6] is of little practical value as a renal function test.

The situation has been well expressed by B. A. Thomas,[5] whose recent untimely death has taken from us a worker of great diligence in the field of urology: "For this purpose the index of elimination of phenolsulphonephthalein and the blood urea nitrogen have served well and faithfully. There are none better or more reliable. In addition to these, in all toxic patients,

the CO_2 combining power of the blood plasma is a routine procedure, and has sufficed to differentiate acidosis from alkalosis, saving many lives by indicating, early, the appropriate line of treatment."

CONCLUSIONS

The phthalein test is most valuable in showing the early impairment of renal function and is, therefore, the most important test to put the surgeon on his guard in cases where prostatectomy is contemplated. Blood chemistry usually demonstrates renal changes at a much later stage, but, taken in conjunction with the phthalein test, is of great value. By a remarkable inverse parallelism, the two tests furnish a graphic demonstration improvement under treatment of great value to the clinician. Indigocarmin, while valuable in the cystoscopic detection of ureteral orifices where catheterization is difficult, and in giving a rough idea of the renal function of the two sides, is not nearly as accurate as the phthalein test, or so valuable an index as to the operability of prostatectomy cases. For more accurate determinations of the phthalein test we have presented a new rotating disc colorimeter and a new system of charting in which not only are all the important clinical and laboratory examinations provided for, but also graphic curves, which show, at a glance, the phthalein output and the blood chemistry. These charts furnish the clinician with a ready method, by means of which, at a glance, the conditions present and the improvement from day to day under treatment may be seen.

BIBLIOGRAPHY

1. ABEL and ROWNTREE: Jour. Pharm. and Exper. Therap., 1909, i, 231.
2. REMSEN: Am. Chem. Jour., 1884, vi, 280.
3. ROWNTREE, L. G., and GERAGHTY, J. T.: The phthalein test. An experimental and clinical study of phenolsulphonephthalein in relation to renal function in health and disease. Arch. Int. Med., 1912, ix, 284-338.
4. SHAW, E. C.: A study of the curve of elimination of phenolsulphonephthalein by the normal and diseased kidneys. Jour. Urol., 1925, xiii, 575.
5. THOMAS, B. A.: Present status of kidney function tests. Jour. Urol., 1930, xxiv, September.
6. YOUNG, H. H., and WATERS, C. A.: Urological Roentgenology (second edition). Paul G. Hoeber, Inc., New York.

TESTS OF FUNCTION OF EACH KIDNEY SEPARATELY: A COMPARISON OF THE VALUE OF SPECIFIC GRAVITY OF URINE WITH EXCRETION OF PHENOLSULPHONEPHTHALEIN

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Fullerton, in 1922, called attention to the diminution in specific gravity of the urine from an affected kidney and advocated determination of the specific gravity of the urine from each kidney separately as a differential functional test. He found, after testing 117 patients in whom the urinary tract was presumably normal, that 111 secreted urine of the same specific gravity from each kidney; of forty-one patients with unilateral renal stones the specific gravity was lower on the affected side in thirty-one (75 per cent of the cases). In a series of cases of renal tuberculosis he found the test accurate in 97 per cent; in cases of renal neoplasm, in 77 per cent, and in cases of hydronephrosis, in 100 per cent. The test failed only in the cases of essential hematuria. In these, Fullerton hoped to be able to demonstrate which was the affected kidney when bleeding was not present but he was forced to admit that to determine this the patient must be examined in the course of an attack of hematuria.

Keith and Snowden, in 1914, had shown by experiments on animals that artificial hydronephrosis was accompanied by true polyuria. Although unilateral anuria has always received much attention, unilateral diuresis was little considered until Fullerton's paper appeared, in 1922.

Two years later, in 1924, Todd and Crowell presented a paper before the Southern Medical Association in which they reported comparison of the method of Fullerton with the method in which phenolsulphonephthalein is used. In this work, they estimated the function of each kidney separately. They ran the tests simultaneously in 131 cases and stated: "In all cases ex-

cept four the two tests ran parallel, that is, the dye concentration and the salt concentration were increased or diminished to a similar degree. We have yet to see a case in which the ultimate clinical or operative findings and the specific gravity test did not agree. For practical purposes we have come to regard a difference of two or three points between the gravities of the two urine specimens as of little importance, usually representing technical errors." Todd and Crowell emphasized the disadvantages of the test with phenolsulphonephthalein, calling attention to the frequency with which catheters permitted varying percentages of the dye to run into the bladder. They felt that the usual fifteen minutes for collecting the specimens is unduly long and often a severe trial to certain classes of patients.

Todd, in January, 1929, reported further observations on the test of specific gravity. He had used it in 200 more cases and regarded it as the best single means of determining the comparative function of the two kidneys.

If such a test should prove to be equally satisfactory in the hands of others, it would save many hours now consumed in giving phenolsulphonephthalein, collecting urine and estimating the proportion of the dye excreted. The test based on specific gravity also would make possible cystoscopic examination of many more patients in the same room, a most important factor when hospital or office space is limited and expensive.

Therefore, I have compared results in cases in which the function of each kidney separately was estimated by means of specific gravity of the ureteral specimens, as well as excretion of phenolsulphonephthalein. Care has been exercised to be sure that the catheters were not irrigated to facilitate drainage. The test of specific gravity was made by the suspension method. A drop of the urine from the specimen to be examined microscopically was placed in an equal mixture of stanisol (a light petroleum) and carbon tetrachloride; an excess of one or the other fluid was then added until the drop remained suspended, at which time the specific gravity of the mixture was determined with a hydrometer.

Seventy of the patients examined were thought to have a urinary tract that was free of abnormality. In nineteen (27

per cent) the specific gravity of the urine from each kidney was the same. If differences of 0.002 are regarded as within normal limits of equality, then in fifty-six of the cases the specific gravity of urine from each kidney indicated equality in function, or that the test has accuracy of 80 per cent. Of fourteen cases in which the discrepancy in specific gravity of the urine from the two kidneys was great, the excretion of phenolsulphonephthalein from the two kidneys was equal in four and indicated that the function of the two kidneys was approximately equal in the majority (Table 1).

TABLE 1

DIFFERENCES OF MORE THAN 0.002 IN THE SPECIFIC GRAVITY BETWEEN THE URINE FROM THE TWO KIDNEYS

Specific gravity		Phenolsulphonephthalein*		
Right kidney	Left kidney	Right kidney	Bladder	Left kidney
1.024	1.020	15	1	15
1.017	1.014	15	..	15
1.024	1.020	15	1	15
1.027	1.024	20	6	15
1.024	1.032	15	..	10
1.011	1.008	10	25	10
1.019	1.015	10	..	15
1.032	1.018	6	10	15
1.024	1.027	..	15	15
1.014	1.011	6	6	15
1.021	1.013	6	20	10
1.018	1.009	6	10	4
1.010	1.013	4	..	1
1.013	1.004	5	20	4

*Per cent excreted in fifteen minutes.

In a series of twenty-seven cases in which there were unilateral stones, the specific gravity was lower on the affected side in fifteen. If one considered only cases in which there were variations of greater than 0.002, there were but eleven cases of the twenty-seven in which there was sufficient diminution in specific gravity of the urine of the affected kidney to be of diagnostic value. The average of the results of the tests with phenolsulphonephthalein indicated return of less phenolsulphonephthalein on the affected side, even when the specimens from the bladder were disregarded. The averages of the specific gravity

of the urine from the affected kidney and from the normal kidney differed only 0.002; therefore, they could not be regarded as significant (Table 2).

There were ten cases of hydronephrosis. In only five the specific gravity of the urine from the affected kidney was lower than that of the urine from the normal kidney and in one of these cases, in which at operation 90 per cent of the renal substance was found to be destroyed, the discrepancy between the specific gravities of the urine of the two kidneys was 0.002. The determinations with phenolsulphonephthalein gave evidence

TABLE 2

FUNCTIONAL TESTS OF THE KIDNEY

Diagnosis	Cases	Specific gravity of urine		Phenolsulphonephthalein*		
		Right kidney	Left kidney	Right kidney	Bladder	Left kidney
Left renal stones	15	1.032	1.017		5	2
		1.021	1.018	4	20	15
		1.020	1.016	20	4	15
		1.016	1.011	15	15	2
		1.017	1.009	15	2	
		1.017	1.011	10		2
		1.014	1.012	10	15	10
		1.010	1.008	15		6
		1.008	1.008	15	5	10
		1.017	1.017	4	10	10
		1.008	1.008	10	5	15
		1.017	1.018	1	20	1
		1.008	1.012	10	2	10
		1.007	1.008	1		7
		1.008	1.009	20	10	1
		Average				
		1.014	1.012	10.2		7.0
Right renal stones	12	1.016	1.030	10		25
		1.011	1.016	10	10	10
		1.020	1.022	10	10	1
		1.020	1.021	4	6	10
		1.009	1.010	5		20
		1.007	1.008	5	22	20
		1.013	1.017	4	15	15
		1.010	1.010	15		15
		1.009	1.008	2	10	10
		1.014	1.013	15	20	4
		1.009	1.008	10	15	15
		1.022	1.019	10	5	15
		Average				
		1.013	1.015	3.3		13.3

*Per cent excreted in fifteen minutes.

Right hydronephrosis	5	1.012	1.014	6		10
		1.008	1.012	1	4	3
		1.009	1.011	2	2	10
		1.008	1.008	6	15	2
		1.009	1.008	4		15
Left hydronephrosis	5	1.022	1.015	20	4	
		1.014	1.011		2	
		1.013	1.013	15	15	1
		1.011	1.012	20		
		1.008	1.009	20	10	
Right tuberculosis	4	1.017	1.022	10	6	15
		1.014	1.021		10	
		1.012	1.013			10
		1.008	1.008	10	15	10
Left hypernephroma	3**	1.017	1.014	15	2	1
		1.020	1.015	15		
		1.028	1.012	15	6	
Right hypernephroma	1**	1.013	1.018	4	10	2
Right essential hematuria	3	1.030	1.018	10	15	5
		1.022	1.016	15		6
		1.016	1.018	15	10	6
Left essential hematuria	1	1.009	1.009	4	15	20
Right renal infection	3	1.016	1.018	15	3	4
		1.012	1.020	20		15
		1.007	1.008	10	2	20
Left renal infection	5	1.031	1.014	10		5
		1.018	1.014	15		4
		1.017	1.009	25	10	1
		1.013	1.011	10	25	2
		1.019	1.022	10		15
Bilateral pyelonephritis	9	1.016	1.021	15	2	15
		1.012	1.027	15	6	15
		1.021	1.011	15	2	10
		1.020	1.018	10	30	10
		1.011	1.012	15		15
		1.014	1.014	25	2	20
		1.015	1.017	25		30
		1.009	1.010	15		10
		1.009	1.008	10	20	5

**Destruction of kidney in these cases was 70, 100, 80, and 20 per cent respectively.

of better function of the normal than of the injured kidney in eight of the ten cases (Table 2).

In four cases of renal tuberculosis the specific gravity of the urine from the affected kidney was lower than that of the urine from the normal kidney in every case except one and in this case the specific gravity of the urine from both kidneys was the same. The results of the tests with phenolsulphonephthalein in the cases of renal tuberculosis were not satisfactory unless the amount of dye which leaked around the catheter into the

bladder is added to the amount which was returned from the normal kidney.

In four cases of hypernephroma the specific gravity was radically reduced on the affected side in every case (Table 2). In all cases but one the results of the test with phenolsulphonephthalein were equally good.

In four cases of essential hematuria there was no uniformity in the effect on specific gravity; that of the urine from the affected kidney was higher than that of the urine from the normal kidney in two cases, equal in one case, and lower in one case. The excretion of phenolsulphonephthalein was higher from

TABLE 3. SUMMARY

Diagnosis	Cases	Tests of specific gravity, correct cases	Accuracy, per cent
Urinary tract normal	70	56	80
Stones	27	9	33
Hydronephrosis	10	5	50
Tuberculosis	4	4	100
Essential hematuria	4	2	50
Unilateral infection	8	8	100
Pyelonephritis	22	15	68
Total	145	99	68

the affected kidney than from the normal kidney in every case (Table 2).

In eight cases of unilateral renal infection of unknown origin the specific gravity of the urine from the affected kidney was lower than that from the normal kidney in all but one case (Table 2) and in this case the excretion of phenolsulphonephthalein indicated a better function from the involved than from the normal kidney.

Twenty-two cases of bilateral pyelonephritis were studied. In nine the excretion of phenolsulphonephthalein seemed to denote approximately equal function in both kidneys. The specific gravity of the urine from the two kidneys, however, was equal in only one case and in three the discrepancy was 0.005 or greater

(Table 2). A critical review of the twenty-two cases disclosed that the results of the tests of specific gravity were about equivalent to those with phenolsulphonephthalein in fifteen of the cases (about 70 per cent).

Table 3 gives a summary of the results in the 145 cases. In ninety-nine the tests of specific gravity seemed to correspond with those in which phenolsulphonephthalein was used, and to be comparable to the known clinical data. This gives an average accuracy of approximately 70 per cent provided the test with phenolsulphonephthalein and the clinical estimate are accurate. The test of specific gravity, then, is a decided aid in diagnosis but does not exceed in accuracy the test with phenolsulphonephthalein, and should not replace it.

BIBLIOGRAPHY

1. Fullerton, Andrew: Unilateral diuresis. Surg., Gynec. and Obstet., 36:16-26 (Jan.), 1923.
2. Keith, N. M., and Snowden, R. R.: Functional changes in experimental hydronephrosis. Arch. Int. Med., 15:239-264 (Feb.), 1915.
3. Todd, L. C.: Separate kidney function: further observations on the specific gravity test and improvements in technic. Jour. A. M. A., 92:228-229 (Jan. 19), 1929.
4. Todd, L. C., and Crowell, A. J.: Separate kidney function: comparative value of dye excretion (phenolsulphonephthalein) and salt excretion (specific gravity) as tests of differential kidney function. South. Med. Jour., 18:282-287 (April), 1925.

DISCUSSION

DR. WILLIAM A. FRONTZ (Baltimore): As Dr. Bumpus has pointed out, there is a definite relationship existing between the relative concentration as well as the output of the phthalein in a given time.

We have more or less routinely determined the urea content or the urea per cent in addition to phthalein, and have found that about the same parallelism exists between the specific gravity and the phthalein elimination.

I think one shortcoming in a certain number of cases with the specific gravity determinations and with the urea determinations is that they are chiefly of relative value; they really do not give the actual excretory capacity of the kidney. Under certain conditions, for instance, of bilateral renal disease in which one kidney, say, is doing three times the work of the other, one is interested in knowing what will happen if the poorer kidney is removed. One should know whether the remaining kidney has an excretory capacity sufficient to meet the extra demand put upon it.

This, of course, can be determined, I believe, only by phthalein. In other words, phthalein will determine the reserve function of the kidney, whereas specific gravity and urea determinations will not.

One type of case, for instance, in which this is of particular value, is the infantile kidney, a kidney which has a very low excretory function, yet puts out a urine which is perfectly normal and which has a perfectly normal specific gravity. Unless the functional value of that infantile kidney is determined, of course serious errors might result from removal of the opposite kidney.

As far as the application of retention tests is concerned, we today limit these tests almost entirely to blood urea, believing that that furnishes information which is just as satisfactory and frequently more so than the determination of uric acid and creatinin. Theoretically, of course, creatinin would seem to be an ideal test, in that it is the end-point of endogenous metabolism and is not influenced by food intake. It is a substance, however, that is excreted with great ease, I think with the greatest ease of any of the nitrogenous products, and one usually finds a very high blood urea before there is any increase above

normal of creatinin in the blood. Putting the normal limit of creatinin at, say, a milligram and a half, six milligrams or eight milligrams is usually regarded as a very serious prognostic sign.

In two cases, however, which we have seen, this test from the prognostic standpoint was faulty. One of these patients having a blood urea in the neighborhood of 100 milligrams per 100 c.c. had for a considerable period a creatinin of 18.6. This test was checked, so I do not think there is any chance of error in it. Despite this great retention of creatinin the patient was mentally clear and had none of the usual signs or symptoms of uremia. He died, however, in uremia six months later.

In another case, a boy of ten having a congenital urethral valve and having a blood urea of 90, the creatinin was 12 mgm., a figure which is usually regarded as indicative of irreparable renal injury. After a week's drainage of the bladder through a ureteral catheter a punch operation was carried out and one leaflet of the valve divided. This completely relieved the obstruction and the patient had good control of his urine. This patient has been followed over a period of five years and his general health has remained excellent. The phthalein is within normal limits and his blood chemistry is normal.

DR. A. VON LICHTENBERG (Berlin): I am very grateful to Dr. Young for his splendid demonstrations of pathological specimens. I am sorry that phenolsulphonephthalein is not used in Germany and that indican is not used in America. I will start the phenolsulphonephthalein test in Germany, and hope to have your satisfactory results.

DR. HUGH H. YOUNG (Baltimore): I am willing to admit that we have not tried the indican test here. I will send Dr. von Lichtenberg some phenolsulphonephthalein if he will send me some indican.

I was greatly interested in the Professor's presentation, and I think it is a great honor and pleasure to have him come to us and bring this very new test. Evidently it is a thing of very great value and something that should be studied comparatively with blood urea and non-protein nitrogen, creatinin and other tests of retention.

I also want to thank Dr. Bumpus for his very interesting presentation again of the work of Fullerton. I know Fullerton

very well and have known him for many years and have realized his great enthusiasm over this test. I recently heard a paper on the same subject by him in London. I think he has undoubtedly made a very positive demonstration of the great value of getting the specific gravity of these separated specimens.

Of course, a thing of that sort cannot be well applied for other than separated specimens, particularly in prostatics where we have to give larger quantities of water and produce very pale urine, and where the specific gravity test cannot be utilized practically at all.

Undoubtedly the test is one of great value. I would suggest that the charts show that possibly the catheters being used are a little too small, because the amount of transversical leakage seems to be unusually large.

DR. BUMPUS: They are No. 4 or No. 5.

DR. YOUNG: Wherever possible we try to use a No. 7 catheter on each side. We think that a fairly large catheter has a great deal to do with the accuracy of the collection and the elimination of the amount of transvesical leakage, because, of course, when there is a considerable transvesical leakage it depends on how good a guesser one is to know from which side it comes.

Undoubtedly this very ingenious method of determining the specific gravity of a drop or two of urine is a very great contribution and ought to make it possible for us to check up our phthaleins with the specific gravity in all these cases. In other words, I think Dr. Bumpus has demonstrated conclusively, in addition to separated phthaleins, that we certainly ought to have separated estimations of specific gravity.

Dr. Fullerton has a marvelous collection of little bulbs by means of which with just a few drops of urine he is able to get the specific gravity. I have tried all over the world to get some myself, but have never succeeded.

THIRD DAY, MAY 24, 1930

ELECTROCARDIOGRAPHIC CHANGES FOLLOWING BLADDER DRAINAGE IN CASES OF PROSTATIC RETENTION

BOLAND HUGHES, M.D.

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In the electrocardiographic examination of the heart in cases of prostatic retention we were interested principally in determining what functional changes occurred in the cardiovascular system following bladder drainage. If it could be found that certain cardiac conditions improved (as estimated by changes in the electrocardiogram) following bladder drainage alone, we would have evidence of the possible etiological influence of prostatic retention in cardiovascular disease.

We were also interested in studying those cases of prostatic retention in which there is a great fall of blood pressure following bladder decompression. This fall of blood pressure occurs more often following the sudden emptying of the bladder but it also occurs after careful decompression and frequently results fatally. Is this precipitous fall of blood pressure due to vascular collapse or is it cardiac in origin? The treatment of the condition depends on which of these factors is responsible. If the condition be principally cardiac, vasoconstrictors should be avoided so as not to overload a weakened heart. If the condition be principally one of vascular collapse, cardiac stimulation will not be as effectual as ephedrine, which can be used in doses sufficient to control the blood pressure without fear of overtaxing the heart.

From a series of twenty cases of prostatic retention, in which electrocardiograms were done before and after the institution of bladder drainage, three have been selected to serve as a preliminary report. One case is that of partial auriculoventricular heart block which cleared up within one week following cystostomy. The second case is one of auricular fibrillation which

improved after cystostomy (no cardiac medication used). The third case shows that the great fall of blood pressure which sometimes follows bladder drainage is principally of vascular nature.

Case 1.—Prostatic retention. Residual urine, 180 c.c. Blood pressure, 180/90. Electrocardiogram (Fig. 1) taken on admission of patient to hospital before catheter drainage of bladder was insti-

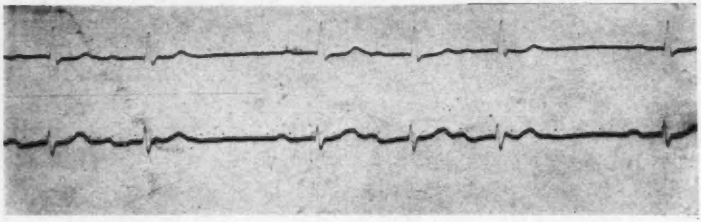

Fig. 1

tuted shows a partial heart block (dropped beats, elongation P-R interval).

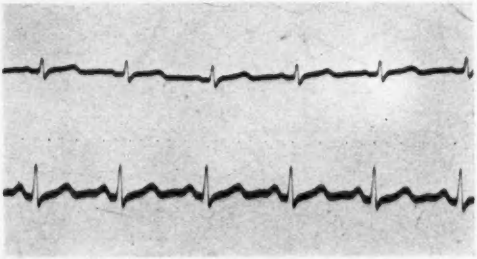

Fig. 2

Figure 2 shows an electrocardiogram of the same patient one week after cystostomy, two weeks after admission to the hospital. There was no cardiac medication. Restoration of normal rhythm. P-R interval normal. Blood pressure, 150/80.

Case 2.—Prostatic retention. Residual urine, 210 c.c. Blood pressure, 130/70. Electrocardiogram (Fig. 3) taken on admission of the patient to the hospital shows auricular fibrillation with irregularity of rhythm.

Electrocardiogram eighteen days later (Fig. 4), one week following cystostomy, shows regular cardiac rhythm. No digitalis was used.

Case 3.—Prostatic retention. Residual urine, 220 c.c. Blood pressure on admission, 220/110.

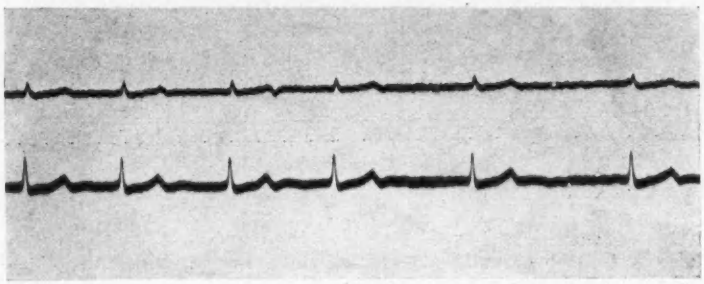

Fig. 3

The bladder was slowly decompressed (urethral catheter). Blood pressure fell in ten days to 110/40. Electrocardiogram was taken on admission of the patient and when the blood pressure was at the lowest level. Ephedrine 0.050 gm. t. i. d. was given for one week with gradual restoration of the blood pressure to 180/100 level which was then maintained without medication.

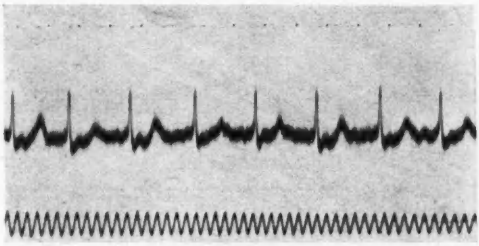

Fig. 4

Electrocardiograms I, II, III (Fig. 5) were taken on admission (I), when the blood pressure was at lowest level (II), and when the blood pressure was restored (III).

When I and II are compared with each other it may be seen that the ventricular complexes in II are not as high as in I. This is not due to cardiac weakness but rather to a lessened energy of

contraction resulting from a decrease in peripheral resistance (energy of contraction varies as to the load).

Electrocardiogram III shows a return of the ventricular com-

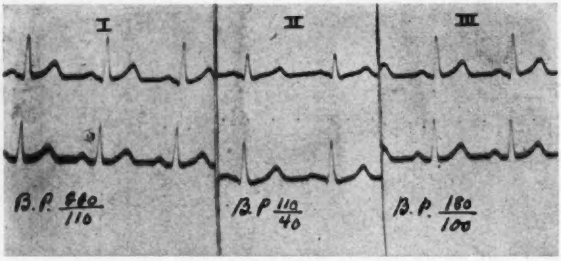

Fig. 5

plexes to approximately their previous height when the blood pressure is restored to a more nearly normal level for the patient.

As Electrocardiogram II shows no irregularities or notchings and as III shows the same normal finding as in I, it may be assumed that the fall in blood pressure was due to a vascular collapse and was not due to a cardiac factor.

SUMMARY

Electrocardiographic changes following bladder drainage in three cases of prostatic retention are presented.

CARCINOMA OF THE PENIS IN RELATION TO THE REGIONAL LYMPH GLANDS

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The purpose of this report is to stimulate discussion on the subject of carcinoma of the penis in relation to the regional lymph glands with special reference to the reticulo-endothelial system. This report may rightly be called a preliminary on the subject inasmuch as the material is not sufficient and the time is not long enough for one to come to a definite conclusion.

Ever since Aschoff wrote his first article some seventeen years ago there have been more than five hundred references made to his paper, and yet when one visits the general hospitals of today there appears to be little or nothing said of the reticulo-endothelial system in connection with the removal of malignant growths.

It is the consensus of opinion of most authors on the subject of cancer that there are two factors always to be taken into consideration; namely, the defense reaction against the cancer cell and the virulence of the malignancy. In other words, there is a sort of balance that must be maintained.

The literature is far too extensive and the theories too common for us to dwell longer on the etiology of cancer. The writer of this paper is of the opinion that when the final chapter of carcinoma is written, the reticulo-endothelial system will play no small part. Aschoff, Landau and Kiyono first pointed out the tremendous importance of the reticulo-endothelial system not only in combating cancer cells but infection as well. This was later emphasized by Schittenhelm, Boener-Patzelt, Goedel, Standenath, Seigmund, Sacks, Oberling, Jaffé, Kolischer and others.

Thus far this paper deals with the entire subject of carcinoma as applied anywhere in the human anatomy. Among the recent articles, one written by Dr. Arthur L. Dean, Jr., of New York, reports seventy-five cases treated by means of radium and X-ray

therapy. He later states that the treatment was satisfactory only in cases of a tumor not more than 3 cm. in size and reasonably superficial and in tumors more extensive than this surgical measures are necessary.

Dean's conclusions in a large number of cases, while not apparently interested in the reticulo-endothelial system, will coincide with ours in a smaller number of cases. Dean's report stated that it was a clinical study with special reference to radium and roentgen rays in the treatment of carcinoma of the penis. Our report emphasizes not only the clinical aspect of epithelioma of the penis but also its relation to the regional lymph nodes as a basis of study in which the reticulo-endothelial system is accepted as a standard.

It will be noted from the case reports that the patients in Case 1 and Case ? both entered the hospital within the same month in 1925; both suffered from carcinoma of the penis. In both cases the regional lymph glands showed the same characteristic hypertrophy. I might mention that in all cases examined by us the superficial lymph glands below Poupart's ligament were the first to become enlarged and palpable and they were always three in number.

In Case 1 a partial amputation of the penis was performed; in Case 2 a complete radical operation was performed. While the lymph nodes on biopsy in both cases revealed them to be negative for carcinoma, the patient in Case 2 died with generalized carcinomatosis within a year and the patient in Case 1, having only a partial amputation without removal of the regional lymph nodes, is surviving and enjoying life, symptomatically well five years later.

In Group II both cases on biopsy showed the lymph nodes to be negative for carcinoma. In both cases a partial amputation of the penis was done with a unilateral resection of the inguinal lymph glands. It is interesting to note that the regional glands in the case not resected showed total recession of the inflammatory process and to date gives no further signs of malignancy.

In Group III it will be noted on the case report that the patient had been treated over a period of several months by X-rays, and at biopsy both the tumor of the penis and the inguinal glands revealed malignancy to be present. In this case,

a total extirpation was made including the resection of all inguinal glands. This patient died five months later from generalized carcinomatosis.

Group IV, according to the case report, showed malignancy of the inguinal glands. It will be further noted that total extirpation was made including the lymph glands, and small X-ray doses were given. Sufficient time has not elapsed to determine the final result, although the patient is symptomatically well.

Group V. In all the remaining cases on biopsy, the inguinal lymph nodes were negative and a partial amputation of the penis was done. Seven months have not yet elapsed since the time of operation and the patients are all symptomatically well. These patients were given fractional doses of X-rays.

It is interesting to note that both in the cases of unilateral resection and in the cases where no resection was made the inflammatory condition of the regional lymph glands has disappeared. It will also be noted that the clinical case reports bear out well the theoretical consideration of the reticulo-endothelial system defense.

CASE REPORTS

Case 1.—Mr. A. K., aged sixty, married, street cleaner, entered the hospital July 13, 1925, complaining of an inflamed area on the end of the penis which was accompanied by a profuse discharge and an occasional jerking sensation. These symptoms had been present for two months and were progressively getting worse.

The past history was negative. Physical examination was essentially negative except for the inflamed area on the penis, which was of cauliflower-like appearance and bled profusely during the examination.

Biopsy revealed a carcinoma.

The patient was operated on July 29 with a partial amputation of the penis being performed. No resection of the glands was made. No follow-up treatment with X-ray was given.

The patient is still alive and enjoying the best of health and is symptomatically well.

Case 2.—Mr. B., aged sixty-five, married, entered the hospital November 17, 1925, suffering with a cauliflower-like growth and bilateral palpable lymph glands. The patient stated that he first noticed a small papule on the penis about eighteen months previous to entering the hospital.

Physical examination revealed an elderly white male, emaciated

and having visible anemia. The examination revealed the inguinal glands to be visible, hard and scattered. The genitalia presented a cauliflower growth of the glans of the penis.

The patient was operated on November 23, at which time a complete removal of the penis and dissection of the lymph glands was done.

Postoperative examination bore out the same pathological findings as those at biopsy, namely carcinoma of the penis with no metastatic involvement of the lymph glands.

The patient died May 3, 1926, the diagnosis being generalized carcinomatosis.

Case 3.—S. H., aged fifty-seven, a laborer, married, entered the hospital June 25, 1929, complaining of a growth on the penis which had been present for nine years. This tumor had never caused discomfort except for occasional pain and occasional discharge.

Physical examination was essentially negative. The examination of the genitalia revealed two small nodular masses on the glans penis, the surrounding tissue somewhat indurated. No pain was elicited on palpation of the masses. The inguinal glands on both sides were palpable, not firm or tender.

Biopsy of the growth showed carcinoma.

The patient was operated on July 17, 1929, at which time the dorsal penis artery was isolated and ligated. On August 4, 1929, the tumor masses were fulgurated with diathermy.

Healing was prompt and complete and the patient has apparently been well since.

Case 4.—J. H., aged seventy-one, married, was admitted to the hospital January 1, 1930, complaining of a growth on the penis. He stated that he had first noticed this growth about nine months before coming to the hospital and it was progressively becoming larger. Pain in this growth is not constant. Bleeding of the mass was also present.

Past history and physical examination were essentially negative except for a large indurated cauliflower-like mass which involved almost the entire glans penis. The mass was tender to touch and bled freely. The inguinal glands on both sides were enlarged, somewhat firm and several were tender on deep pressure.

Biopsy showed the mass to be a carcinoma of the glans penis.

On January 25, 1930, a partial amputation of the penis was done. The patient made an uneventful recovery. The operation was followed by a course of deep X-ray therapy and to date there has been no evidence of recurrence.

Case 5.—C. B., aged 46, married, entered the hospital January 16, 1930, with a history of an ulcer on the penis of nine months

duration. During this time the ulcer became constantly larger, painful and bled at times. This was associated with some loss of weight.

Past history revealed that he had gonorrhea at the age of twenty-two.

Physical examination was negative except for an ulcer on the glans penis, presenting a cauliflower-like appearance, which had a tendency to bleed upon the slightest touch. Adenopathy in the left inguinal region was marked.

Biopsy revealed a carcinoma of the penis and the lymph glands.

Deep X-ray therapy was given over the inguinal region and on January 22, 1930, a radical amputation of the penis and resection of the left inguinal lymph glands was done. The patient made a good recovery. He has been given deep X-ray therapy with no evidence of recurrence thus far.

Case 6.—Mr. H., aged forty-seven, a carpenter by trade, entered the hospital October 4, 1929, complaining of penile growth of twelve months' duration.

The patient presented a picture of moderate cachexia. Physical examination was essentially negative except for a flat ulcerated growth on the penis which involved the entire glans of the penis; the lymph glands on both sides were easily palpable and hard.

Biopsy of the growth and the inguinal lymph glands revealed carcinoma.

The patient had been previously treated by massive X-ray doses to the glands and the primary tumor.

He was operated on October 5, 1929. The operation was a radical one with a total emasculation and removal of the lymph glands.

Recovery was slow. After two months the patient began to lose weight rapidly and died February 7, 1930. Examination showed a generalized carcinomatosis.

Case 7.—S. F., aged twenty-four, single, entered the hospital December 21, 1929, complaining of an ulcer on the end of the penis of ten months' duration. This was first diagnosed as chancre by some physician and treated accordingly. The condition became no better and the patient entered the hospital for treatment. He stated that he had had gonorrhea three years previously.

Physical examination was essentially negative except for a necrotic, ulcerated area on the glans penis. The entire glans was swollen, as was the shaft of the penis for about one-half inch below the corona. The ulcer itself was tender to touch and a purulent discharge was present.

On January 6, 1930, the patient was operated on, the penis

being amputated at the base, the lymph glands on both sides removed.

The patient made an uneventful recovery and no recurrence is evident to date. The diagnosis was carcinoma.

Case 8.—J. F., aged fifty-eight, married, was admitted to the hospital February 26, 1930, with a history of a growth on the penis of three months' duration. The growth was becoming progressively larger and during the month prior to admission it had become painful and a discharge was constantly present.

The patient stated that he had had gonorrhea thirty-five years ago.

Physical examination revealed an ulcer on the glans penis about 1.75 cm. in diameter.

Biopsy of this growth showed carcinoma.

A partial amputation of the penis was done on March 5, 1930. The patient died two days later of bronchopneumonia.

Case 9.—T. M., aged sixty-three, was admitted to the hospital on April 2, 1930, with a history of a growth on the penis of unknown duration. He felt no ill effects from this growth.

Physical examination showed a ragged, markedly indurated tumor mass which had involved almost the entire glans penis. The inguinal glands on both sides were enlarged. Biopsy of this mass showed the tumor to be carcinomatous.

X-ray therapy was given over both inguinal regions and on April 12, 1930, a partial amputation of the penis and a cystotomy were done. The patient developed broncho-pneumonia on the seventh postoperative day and died.

Case 10.—J. C., aged thirty-two, was admitted to the hospital December 19, 1929, with history of a growth on the penis of five years' duration. He stated that he knew this growth was present but it had not been painful.

Physical examination revealed a mass 3 cm. in diameter underlying the foreskin, covered with a thick discharge. Fairly firm, enlarged lymph glands were easily palpable in both inguinal regions.

Biopsy of the tumor mass revealed carcinoma.

A partial amputation was done on January 8, 1930, and also an excision of the right inguinal glands. The patient made an uneventful recovery and was given a course of deep X-ray therapy.

The glands removed at the time of operation showed no evidence of malignancy, and to date there has been no evidence of recurrence or metastases.

Case 11.—A. M., aged fifteen, entered the hospital March 28, 1930, complaining of sore on the scrotum for the past year. This patient had never been healthy.

Physical examination revealed a very poorly nourished young

boy. There was a large, deep triangular ulcerated area involving the entire scrotum, destroying the testicles, extending from the base of the penis to the anus; the borders were rather sharply outline and somewhat everted.

Biopsy revealed carcinoma.

Repeated blood Wassermanns, Kahns and spinal punctures were negative. Therapeutic tests with neo-arsphenamin, mercury rubs and iodids proved of no avail. In fact the condition became worse. Before operation could be done, the relatives of this boy removed the patient from the hospital.

TREATMENT

The treatment of carcinoma may be divided in the following way: surgical electro-coagulation or diathermy, radium therapy, and X-ray therapy. The therapeutic intervention will have to be divided into two distinct items—(1) mechanical removal of the accessible growth, and (2) the biochemical attack on the causative factors. Surgery cannot entirely ever be dispensed with because, even if chemical therapy should succeed in producing absorption of the intact bulk of the tumor, the already degenerated part of the growth will have to be removed by mechanical means. The other aspect of the therapeutic problem will be the changing of the relation between stimulating and regulating forces.

The author believes surgical intervention is the method of choice for removal of the original growth, inasmuch as the removal of the tumor is only a part of the operation. He also favors the use of X-ray or radium therapy as an after or follow-up treatment. According to some of our best authors on this subject, for instance Holzknecht, Freund, Bachem and others, this therapy is not used for the purpose of killing the cancer cell alone, but, what is much more important, to provoke or stimulate the reticulo-endothelial cells to build up a better defense, and hence arrest the further progress of embryonal changes of the cancer cell. We believe that this has been borne out well in the short series of ours presented.

There seems to be some difference of opinion among the very best authors on the subject of X-ray and radium therapy concerning the dosage. Holzknecht, Freund, Bachem, Sauer and others recommend fractional doses over long periods of time, while Wintz and Warnekoss give massive doses in very active

malignancy. It is the consensus of opinion, however, that most authors believe that fractional doses should be employed as a therapeutic dose to stimulate rather than kill the cancer cell.

CONCLUSIONS

1. The results obtained bear out well Aschoff's theory of the reticulo-endothelial system as a defense against cancer growth.
2. Surgical intervention should be used on the primary growth. Partial amputation of the penis should always be employed where the regional glands are soft and negative on biopsy.
3. Fractional X-ray or radium doses should be employed as a part of the operation in the follow-up treatment. Massive doses of X-ray should be employed in the presence of cancer of the regional lymph nodes.
4. Much time should be spent in determining an adequate dose for the X-rays in each individual case. Massive X-ray dosage may produce a cachexia out of all proportion to the risk undertaken.

CORDOTOMY FOR RELIEF OF PAIN IN THE GENITO-URINARY TRACT

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and

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INTRODUCTION BY DR. ALEXANDER RANDALL

It is certainly not my duty today to draw for you the picture of the man doomed to suffer, until death brings him surcease, from the distressing progress of a malignant neoplasm.

In urology we seem to see such an aggravated form of human suffering. Rarely does carcinoma of the stomach, or other abdominal viscera, keep a man alive to suffer for such periods of time, too often prolonged beyond endurance, as is seen in carcinoma of the bladder base, or malignant recurrence from primary growth in prostate or testicle. We can, each of us, I am sure, look back to recall the most distressing pictures, exemplifying human endurance and bravery under the most prolonged, unrelenting and exquisite suffering.

While others are searching for the true pathology, the etiology, yes, even the cure of cancer, many of us carrying on the clinical work of our day, have to aid the sufferer in bearing his burden. While the hypodermic needle gives periods of comparative comfort, the true God-given relief would be something that would give a complete and continuous analgesia to pain.

It was in this field of endeavor that Dr. W. G. Spiller first conceived the possibility of doing a partial cordotomy, at which the anterolateral columns of the cord would be cut, the portions that carry pain to the cerebrum. To Dr. Charles H. Frazier belongs the credit for developing of the technical side of the operation. At Dr. Frazier's clinic for neurological surgery, at the University of Pennsylvania, this operation is now one of fairly frequent performance, for since its first development in October, 1916, it has been performed thirty-nine times; thirteen of these operations having been done in the last two years.

It is my pleasure to introduce Dr. Francis C. Grant, of the Department of Neuro-Surgery, who has been especially interested in the varying phases of the problem of pain control, and who has himself repeatedly performed the operation of cordotomy.

Malignant tumors involving the genito-urinary tract all too frequently cause pain, and this pain is constant day and night, intractable and severe. Hitherto our only means of controlling the pain consisted of increasing doses of morphin, an intermittent semi-relief at best. No more distressing group of patients exists than those doomed by intrapelvic malignancy to die painfully and slowly, riddled with morphin, waiting with as much fortitude as they can muster until death mercifully ends their suffering.

The last few months of life can be made comfortable for these unfortunate patients by sectioning the pain fibers in the spinal cord on one or both sides, a procedure which in experienced hands is neither difficult nor dangerous. In 1904 Spiller[9] by careful clinical observation brought forward the first conclusive evidence that pain sensation passed upwards in the spinal cord in the anterolateral or spinothalamic tracts. Convinced of the accuracy of these important conclusions, in 1911, he asked Martin[6] to section the fibers of these spinal tracts in a man suffering intense pain from an inoperable tumor of the lower part of the cord. Following operation the pain was relieved and examination a year later convinced Spiller that this procedure could be properly advised to prevent unnecessary suffering in similar conditions. Spurred on by Spiller, Frazier performed the operation in six cases of extreme intractable pain in the pelvis and lower extremities and reported his results in 1920.[2] Three years later in collaboration with Spiller, Frazier[3] described seven additional cordotomies. As a result of these two reports, together with that of Leighton[5] and the careful description of the operative technic they contained, section of the anterolateral columns was firmly established as a practical method of relieving extensive pain in any part of the body below the level of the ensiform cartilage.

Cordotomy has three definite advantages over posterior rhizotomy and other surgical measures hitherto proposed for relief of pain. By section of the spinothalamic tract anesthesia for pain can be obtained over the entire contralateral half of the body up to within one or two segments of the level of the incision. If the posterior roots exposed in the operative field are also cut the area of anesthesia may extend up to the same segment. Motor function is not impaired, following cordotomy, only pain and temperature sensations being destroyed, while touch, position, and muscle sense remain intact. Cordotomy requires the removal of only three spines and laminæ, thus greatly reducing the operative risk. But this procedure has the disadvantage that unless the incision into the cord is placed accurately, the pain may not be completely relieved or the motor pathways may be damaged, resulting in paralysis of the legs.

The details of the technic of cordotomy need not be described here. Suffice it to say that the fourth thoracic segment is the level at which the section should be made. In this region the cord is easily exposed and because of its relatively small size may be readily rotated for proper placing of the incision. The cordotomy hooks originally suggested for steadying the cord during section are not used routinely at present.. A fine sharp-pointed knife similar to a cataract knife is employed to make the incision; the cord is rotated and controlled by grasping a dentate ligament. Judging from recent experiences and from the results of Foerster,[1] Stookey,[10] and Wilson and Fay,[11] it seems essential to section a quadrant of fibers on the surface of the cord from exactly the insertion of the dentate ligament anteriorly around to a point just beyond the emergence of the corresponding anterior root. If all the superficial fibers between these points are cut it is not necessary to carry the incision beyond a depth of 2.5 mm. This statement may seem at variance with the reports of Sicard and Robineau,[8] Peet,[7] and Horarx,[4] who state that in their opinion an incision of 2.5 mm. in depth does not reach all the pain fibers, but it is felt that their lack of success may be due to failure to carry the section sufficiently anteriorly on the surface of the cord. Foerster, Stookey, and Wilson and Fay state that pain may be obliterated without loss of temperature sense, showing that pain and temperature

sensations may be carried in different areas of the spinothalamic tract. In two recent cases, these findings seem to have been confirmed.

Forty-nine cases of cordotomy for pain have been performed by Dr. Frazier or his associates. The whole series will form the basis for a more extensive report. For the present, only the thirteen cases in which the lesion producing the pain involved the genito-urinary tract will be considered. Six of these patients were men, the remainder women. The average age was fifty years. Twelve had a cancerous growth involving the genito-urinary tract, one suffered from ulcers of the bladder. All these patients required morphin preoperatively in varying amounts up to 6 grains daily to control the pain. Three patients succumbed as a direct result of the operation. Eight patients lived an average of three and one-half months, three being still alive; one eight years (bladder ulcers), one five years (carcinoma rectum) and one four months following operation (carcinoma rectum). Twelve patients were made pain-free permanently by cordotomy, one patient (bladder ulcers) reporting a recurrence of pain on the opposite side which was relieved by a second cordotomy. Bilateral section was made in nine patients, unilateral in four.

A short summary of each case follows:

Case 1.—A. S., female aged forty-two. Pain had been present in the left thigh and buttocks for two months due to carcinoma of uterus, required six to eight hypodermics of pantopon in twenty-four hours for relief. February 21, 1929, unilateral cordotomy of the fourth thoracic segment on right was performed with anesthesia for pain and temperature up to the umbilicus on the left and hypesthesia four inches above this line. Touch was not impaired. There was no weakness of the right leg or involvement of sphincters. The patient was walking on the tenth day. For three weeks after operation she complained of pain in the right leg, which was relieved by ½ gr. of codein by mouth morning and evening. After that she was completely relieved and went about her home in comfort. She died three months later, pain-free.

Case 2.—J. M., male, aged fifty-four, suffered pain in the rectum, bladder and penis following carcinoma of bladder requiring morphin for relief; confined to bed. January 13, 1930, bilateral cordotomy at the fourth thoracic segment was performed under local anesthesia. There was complete loss of pain and tempera-

ture up to the level of iliac crests with hypesthesia to the eleventh rib. There was no loss of touch or motor weakness. Pain was relieved, but the patient continued bed-fast. He developed a sacral decubitus from pressure. Discharged pain-free and requiring no opiates, he lived six weeks without return of pain.

Case 3.—E. H., female, aged fifty-nine, suffered pain in the rectum following carcinoma. She was taking morphin 1.5 to 2 grains by hypodermic daily, and was entirely bed-fast. April 17, 1924, bilateral cordotomy at the level of the fourth thoracic segment was performed with complete anesthesia for pain and temperature up to a level of one inch above the umbilicus; hypesthesia up to the level of the sixth rib. There was no loss of touch. Motor power in the legs was apparently undisturbed. Abdominal distention and vesical retention requiring an inlying catheter occurred. Sacral decubitus developed. The patient was sent home with catheter in place, and died in six weeks. She never complained of pain and required only codein gr. 1/24 by mouth twice at night to sleep.

Case 4.—W. J. W., male, aged sixty-three, suffered pain in the perineum and down the left leg due to carcinoma of prostate, requiring large amounts of sedatives to keep him comfortable. December 22, 1928, bilateral cordotomy at the level of the fifth thoracic segment was performed. There was complete loss of pain and temperature sensation on the right below the iliac crest anteriorly and posteriorly and on the left up to a line 4 cm. below the iliac crest. No motor loss was noted. The patient lived four months, practically free from pain until death, his preoperative pain in the left leg and perineum being entirely relieved.

Case 5.—D. W. M., male, aged sixty-two, suffered pain in the right hip radiating down the right leg due to spreading carcinoma of the prostate, requiring ½ gr. of codein every three hours for comfort. July 5, 1927, section of the left antero-lateral tract was performed. There was complete relief of pain in the right leg; no motor weakness. Incomplete sensory examination showed loss of pain sense up to a line 3 cm. below the umbilicus. Death occurred five days later.

Case 6.—L. M., female, aged forty-nine, suffered pain in the rectum and down both legs to the knee due to carcinoma of the uterus and radium application. Bilateral cordotomy at the level of the fifth thoracic segment was performed. There was complete relief of pain. Pain sensation was lost up to the level of the 6th rib on the right and the iliac crest on the left with hypesthesia on the left continuing up to the sixth rib. No motor loss

was noted. Postoperatively, marked abdominal distention continued for five days. Prior to operation the patient had urinary incontinence, which after operation shifted to retention and overflow. A catheter was introduced to keep her dry. She was discharged pain-free with the catheter in place. She lived for six months and was bedfast only during the last month of her life. There was no recurrence of pain; no opiates were required.

Case 7.—M. B., female, aged 50, suffered pain in the left groin and left leg anteriorly due to carcinoma of the vagina, requiring codein gr. ½ every three to four hours by mouth for comfort. On Octobr 2, 1929, a right unilateral cordotomy was performed at the level of the fourth thoracic segment. Following operation there was complete relief of pain. There was no motor loss, abdominal distention or urinary disturbance. Pain and temperature sensation was lost on the left up to the level of the umbilicus with hypesthesia as high as the nipple-line. The patient remained pain-free on the left side for four months and then developed pain in the right leg which required codein gr. ½ twice at night to enable her to sleep. She died five and one-half months after operation from general metastasis.

Case 8.—M. W., female, aged sixty-six, suffered pain on the left side of the vagina due to carcinoma of the cervix, requiring "large amounts" of opiates to keep her comfortable. A right unilateral cordotomy at the level of the fifth thoracic segment, was performed with complete relief of pain. There was loss of pain and temperature sensation up to the eighth rib on the left, and partial paralysis of the right leg. There was also urinary incontinence requiring an inlying catheter. The patient was discharged and died three weeks later pain-free.

Case 9.—H. C., male, aged forty-six, suffered pain in the bladder region, penis and testicles due to carcinoma of the bladder, requiring ½ gr. codein every three hours for relief. April 23, 1929, bilateral cordotomy at the level of the fourth or fifth thoracic segment was performed. Complete anesthesia for pain and temperature up to the nipple line resulted. There was no motor involvement, urinary or rectal disturbance. All sedatives were discontinued. The patient died pain-free five months later. He was able to return to work for two months before he died.

Case 10.—T. D., male, aged forty-two, suffered pain in the perineum from carcinoma of the rectum. The patient was taking morphin gr. 4 daily for relief. March 22, 1930, bilateral cordotomy at the level of the fifth thoracic segment was performed with complete anesthesia for pain up to the nipple line on the left

without loss of temperature sensation. Anesthesia on the right for pain and temperature extended only up to a line four inches below Poupart's ligament. Abdominal distention and urinary retention were present. Fortunately pain was completely relieved although anesthesia on the right side did not reach the usual level. Abdominal distention disappeared in a week, but urinary involvement continued for three weeks. Morphin was unnecessary after the second week postoperatively. The patient was discharged six weeks following operation, walking from the hospital free from pain. He is still alive.

Case 11.—V. K., female, aged thirty-three, suffered intense vaginal and bladder pain on the left extending down to the sole of the left foot. Pain was probably due to ulcers in the bladder. She was taking 2 grs. morphin a day. November 26, 1921, right unilateral cordotomy on the level of the fifth thoracic segment was performed with loss of pain and temperature sense complete on the left side of the body to a line 2 inches above the umbilicus. There was partial paralysis of the right leg which disappeared in a week, with complete relief of pain on the left side. The patient remained pain-free for a time and then the pain recurred in the right vaginal vault and in the right foot. She returned to the hospital and on September 20, 1922, a second cordotomy was performed on the left at the level of the third thoracic segment. Pain and temperature were lost on the right side of the body to a line 2 inches above the umbilicus. Touch sensation was not affected. There was slight paresis of both legs; marked urinary retention requiring catheterization. Within three weeks urinary control returned and her lower limbs recovered normal power. She left the hospital free from pain and has remained comfortable to date. (Note: Cases 11 and 13 previously reported by Frazier and Spiller, Arch. Neurol. & Psych., 1923, 9:1; Case 12 by Frazier, Arch. Neurol. & Psych., 1920, 4:137.)

Case 12.—L. W. G., male, aged forty-four, suffered pain in the rectum, perineum and pain in both legs due to inoperable carcinoma of the rectum. Large doses of morphin gave only partial relief. On January 18, 1917, bilateral cordotomy at the level of the twelfth thoracic, first lumbar segment was performed. Following operation there was loss of thermal and pain sensation over the right buttock, perineum, posterior aspect of the thigh and over the entire right leg below the knee. There was no sensory loss on the left side; no motor loss in the right or left legs. The patient had frequent attacks of vesicle tenesmus. He required moderate amounts of morphin to relieve pain. A letter received four years later stated that he had no pain in his perineum and

could ride a bicycle comfortably. Unfortunately he had become a morphin addict.

Case 13.—H. W., female, aged thirty-seven, had pain in the sacrum and down both legs due to a rectal carcinoma. Increasing amounts of opiates were needed for relief. On April 30, 1921, bilateral cordotomy at the level of the tenth thoracic segment was performed. Pain in the legs and sacrum was promptly relieved but she complained of a sense of constriction about the rib margin. All morphin was withdrawn. She suddenly developed meningitis eleven days postoperatively and died. No careful sensory examination could be made.

Consideration of this group of cases illustrates the value of cordotomy for the relief of severe intractable pain in the pelvis and lower extremities, due to malignant disease of the genitourinary tract. In every case the pain promptly ceased. Morphin was no longer required. In two cases (7 and 11) in which it seemed to be located close to the midline, a recurrence appeared on the opposite side. In one case (11) the patient was rendered pain-free by a second cordotomy, the other (7) died before her discomfort was sufficient to require further intervention. If the pain is referred to the bladder or rectum and if the growth is spreading rapidly it is wise to perform a bilateral section at once. While there may seem to be a high incidence of loss of sphincter control, the operation is not entirely to blame. In vesical and cervical cancer difficulty in urination is not uncommon. In some of these cases sphincteric function was impaired prior to cordotomy.

The real test of cordotomy is whether or not it offers these pain-racked sufferers definite relief. Is the operation sufficiently effective to warrant advising a patient to have it performed rather than to try to struggle through his last months of life with intermittent relief from morphin? Unquestionably the answer is "yes." It is a merciful act to rid these poor people completely of pain even though it subjects them to major surgery and a week of postoperative discomfort. And furthermore, as knowledge of the relief afforded by cordotomy is more widely appreciated, this operation will be recommended earlier to prevent pain from becoming the harassing factor into which it has all too often been allowed to develop in the past.

BIBLIOGRAPHY

1. FOERSTER: Arch. of Psych., 1927, 81:7.
2. FRAZIER, CHARLES H.: Arch. of Neurol. & Psych., 1920, 4:137.
3. FRAZIER and SPILLER: Arch. of Neurol. & Psych., 1923, 9:1.
4. HORRAX: Arch. Surg., 1929, 18:1140.
5. LEIGHTON: Surg., Gynec. & Obstet., 1921, 33:246.
6. MARTIN: Jour. A. M. A., 1912, 58:1489.
7. PEET: Arch. Surg., 1926, 13:153.
8. SICARD and ROBINEAU: Rev. Neurol., 1925, 1:21.
9. SPILLER, W. G.: Univ. of Penn. Med. Bull., 1925, 18:147.
10. STOOKEY: Jour. of Nerv. & Ment. Dis., 1929, 69:552.
11. WILSON and FAY: Arch. Neurol. & Psych., 1929, 22:638.

DISCUSSION

DR. HERMON C. BUMPUS (Rochester, Minn.): In Dr. McKenna's paper he spoke of two points in connection with malignancy, namely the resistance of the host and the degree of malignancy of the tumor. In using radium or X-ray therapy, I think that a third point is more important than the other two, and that is the accessibility of the lesion, as the success or failure of the treatment depends almost entirely upon it. In carcinoma of the lip good results are obtained because of accessibility; that is also true of tumors of the skin and of the cervix. In carcinoma of the penis we have that accessibility, so we have felt radium and X-ray therapy were much preferable to excision.

I also want to confirm Dr. McKenna's findings in regard to dosage afterward. I have felt that repeated dosage over a period of time rather than massive doses have given us better results. I found to my sorrow that in cases of carcinoma of the prostate when massive doses were given metastasis and general diffusion of the malignancy frequently followed.

DR. HERMAN L. KRETSCHMER (Chicago): I wish to take this opportunity to thank Dr. Grant for coming to our Society and presenting his very interesting paper. I feel sure that with this apparently relatively simple procedure, we shall have a therapeutic agent of great value.

The distress and the pain that the sufferer from carcinoma of the bladder or prostate has is very great and very extreme. If, by so simple a procedure, we can relieve these patients of their pain and their distress and get them in such condition that they can stop the use of morphin and go back to work, I think it is something worth while.

DR. GILBERT J. THOMAS (Minneapolis): I think that we miss a point if we do not emphasize what Dr. McKenna said concerning X-ray therapy. In some parts of the country X-ray therapy has been taken over by physicists who are able to measure X-ray dosage sometimes better than the physician who has not had training in physics or in electrical engineering. Still the physicists, in spite of the fact that they are able to measure accurately X-ray dosage, do not at all know how to treat the patient and will not take into consideration the things about which

Dr. McKenna spoke. In a great many instances patients are referred to a man who does know X-ray dosage and can measure it accurately, but he will destroy the patient sometimes quicker than a physician who is giving deep therapy and who is treating the patient.

I don't know what the experience is in the larger cities, but with us it is rather difficult to find someone who really knows X-ray dosage and knows how to apply it to a patient.

DR. CHARLES M. MCKENNA (Chicago): I want to bring out one point concerning which Dr. Thomas spoke. I heard Dr. Lower say the same thing yesterday. Usually we operate on a patient and send him down to the X-ray laboratory to be given some X-ray. Now the average X-ray man who is doing that kind of work is interested only in making pictures. At the University we have a man who is a professor of biophysics, and he is interested in the treatment of patients and not in pictures. He is the other kind of man; he is interested in the dosage of X-ray as it is applied to patients, and that is the thing that I think we have to get clear. We must have a man who is interested in the treatment alone and is not interested in taking pictures.

DR. ALEXANDER RANDALL (Philadelphia): I should like to accentuate the factor, in the operation that Dr. Grant has described, that the patients do not lose their power of locomotion; they simply lose the pain. It is rather startling to see a man who has had an operation of this character walking around the ward or in his room, and yet I can assure you it is a most gratifying thing, because I know we are all probably too familiar with the pitiful picture.

The result can possibly be better summarized in the three words with which one of Dr. Frazier's patients greeted him on his first postoperative visit to the room. She put her hand in his and said, "This is heaven."

RECURRENT BENIGN PROSTATIC OBSTRUCTION*

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Until the recent experiences, which form the basis of this communication, I had no idea that after a complete removal of a benign hypertrophied prostate, regeneration of prostatic tissue could take place to the degree of forming a typical benign prostatic hypertrophy with the return of the clinical symptoms of prostatism. I think the belief is generally held that following the complete removal of a benign prostate, a similar obstruction does not recur. That this is possible seems to be a matter of primary importance. It is for this reason that I wish to record these recent instances and to get an expression of the experiences of other members of this Society.

It is a matter of interest that two of my patients, with this condition, were operated upon within a few days of each other, and also when this condition, unique in my experience, led to inquiry, I found that Dr. Bransford Lewis had recorded a similar observation before the American Urologic Association at the Vancouver meeting last year, and that other examples of the same phenomenon were on record. Thanks to the kindness of Dr. Lewis in letting me read his paper, which has not yet been published, I have been made conversant with the details of his report and also with other examples of this condition recorded by Andre, Bazt, Blum, Bryan (three cases), Casariego, Constantineseu, Fronstein and Meschebowski, Federoff, Hedinger (two cases), Honegger, von Illyes, Loumeau, Lumpert, Orth, Takahaski, Tandler and Zuckerkandl, Tangwall and Young (three cases). I find that Gregoras records 1 per cent of recurrences in 300 suprapubic prostatectomies in the clinic of Rafin, and Illyes has observed three occurrences in a series of 470 patients. Gregora has collected thirty examples, including mostly the reports just mentioned. It would seem, therefore, from this array of reported instances that recurrence of

*Read by title.

benign prostatic hypertrophy following a radical prostatectomy should be more generally appreciated. I am, therefore, particularly interested to know the experiences of other members of this Society in order that this matter, which to me was unknown until recently, may be more generally appreciated.

The cause of recurrence of benign prostatic hypertrophy seems to be a matter of thory. Takahaski advances the idea that the prostatic capsule is a tissue composed of flattened glands which will take on an activity of regeneration of the gland structure when the pressure has been removed by prostatectomy. Hedinger rather substantiates this view by finding distinct recurrence of glandular tissue in autopsy specimens two and four months after prostatectomy. This theory also has the support of Tandler, Zuckerkandl, Honegger and Blum. Fraudenberg, at first a supporter of this theory, later came to believe that the regeneration did not take place from the glandular tissue of the so-called capsule, but from small, adenomatous nodules left at the time of the first prostatectomy.

Still another explanation is offered by Jacoby. He divides the glands of the prostatic urethra into mucous (which do not concern us), submucous, and prostatic. He points out that the submucous glands form the cervical group about the vesical neck and may give rise to the pathological middle lobe, and that they are also located on the anterior or ventral wall of the urethra. He claims that he has demonstrated by histological study that these two groups can develop even into the muscularis. Jacoby believes that these urethral glands are not the only ones to undergo hypertrophy, but on each side of the ventral group there is a particular glandular zone, often continuous with the prostatic glands. These urethral prostatic glands, he believes, are the site of the hypertrophic centers. He suggests that as they are continuous with the prostatic glands in the prostatic capsule, "nuclei of hypertrophy" may exist. He believes that these so-called nuclei of hypertrophy normally play but a secondary part but become active after extirpation of the central glandular tumor, which has compressed them, and may undergo such expansion as to form new prostatic tissue even to the point of producing obstruction by overgrowth.

Whatever may be the true explanation, the fact that prostatic

tissue reappears within the prostatic capsule, and may continue to grow to the point of producing obstruction of the true hypertrophy type, seems to be a fact. In this connection, we have occasionally examined patients after prostatectomy, who seem to have a prostate and in whom, did we not know the facts, it would be difficult to believe that the gland had been removed. None of these patients, however, has had the recurrent symptoms of prostatism. This observation, however, fits in with the matter under consideration and it may be that recurrent prostatic tissue is quite common and that the reason we do not see more evidence of recurrent obstruction from such hypertrophy is that the prostatic patient is usually so aged that he dies before there is sufficient time for the regrowing gland to reach the point of obstruction.

In this connection it is of interest to note the ages of the patients and the time elapsed between the first prostatectomy and the recurrent symptoms of obstruction. Dr. Lewis' patient was sixty-one. Recurrent obstruction symptoms appeared in approximately twelve years. My patients were: (1) Fifty-nine years with recurrent symptoms in eight years; (2) sixty-four years with recurrent symptoms in seven years; (3) fifty-three years with recurrent symptoms in thirteen years. I think it may be said that the ages of these four patients place them among the younger group requiring prostatectomy and that the recurrent symptoms at twelve, eight, seven and thirteen years is a rather longer period of time than most prostatics live after operation. So it may be that if those having prostatectomy should live long enough we would see more recurrent growths. Whether or not this be true, it certainly suggests that in the younger group, that is about sixty or below, with the probably greater expectancy of life, we may find more recurrences. Since becoming aware of the possibility of regrowth this is a matter which we will check more carefully in the future than in the past.

Dr. Lewis' patient, which he records in detail, had a suprapubic prostatectomy performed by Dr. Lewis in April, 1916. The gland was enucleated in one piece and the patient made an uneventful convalescence and remained well for approximately twelve years. He then again had the symptoms of prostatism.

Rectal examination showed what Dr. Lewis terms a "renewed" prostate, and cystoscopy revealed a large, intravesical intrusion. The gland was removed by a two-stage suprapubic operation. Dr. Lewis states that the enucleation was easily performed, as it was also in our patients. In other words, there seems to be no added difficulty in the technical procedure because the gland had previously been enucleated. Our patients' histories and findings are quite similar.

Case 1.—This patient, sixty-seven years of age, had a two-stage suprapubic prostatectomy performed by Dr. Hugh Cabot in October, 1919 (he then being fifty-nine years of age). He remained well for eight years, when he began to have increased frequency and difficulty in emptying the bladder. Two weeks prior to our seeing him he had retention and was catheterized several times by Dr. Seldom B. Overlock of Pomfret, Connecticut, who sent him to us.

The general examination showed nothing extraordinary. Rectal examination showed a very large, benign, hypertrophied prostate. A coude catheter was tight in the prostatic urethra and there were 6 ounces of foul residual urine. The urinalysis was that of cystitis. There were no renal elements. Cystoscopy showed that the prostate projected in all quadrants and presented the usual picture of a considerable intravesical enlargement. There was moderate bladder trabeculation and the capacity was 8 ounces.

On February 13, 1929, approximately ten years after Dr. Cabot had done the suprapubic prostatectomy, we did a suprapubic cystotomy for drainage. It was not until March 19, 1929, approximately four weeks later, that the patient was in condition for prostatectomy. At operation, the prostate gave the typical picture of a moderate intravesical hypertrophy, the left lobe being slightly larger than the right. The gland enucleated easily and there were many small concretions between the gland and the capsule. There was nothing about the appearance of the gland or the features of the operation that differ from the condition usually observed, with the exception of the presence of the concretions between the gland and capsule. The patient made an uneventful recovery and is well at present.

Case 2.—This patient, aged seventy-four, had a two-stage suprapubic prostatectomy by Dr. John Bottomly in April, 1919, being then sixty-four years old. He remained well for seven years and then, three years before we saw him, began to have frequency, which gradually increased until it occurred every two hours during the day and night. The frequency became so dis-

tressing that he finally consulted Dr. Walter Mansfield, who referred him to us.

The general examination showed nothing of importance. Rectal examination showed the prostate to be a moderately large, benign, hypertrophied gland. A No. 20 coude catheter was passed to the bladder with but little obstruction. There were 10 ounces of residual urine, however. The urine was that of a chronic cystitis. There were no renal elements. Cystoscopy was very unsatisfactory because of the patient's nervousness, but enough was observed to establish the fact that there was considerable intravesical projection. X-ray examination was negative.

On February 28, 1929, approximately ten years following Dr. Bottomly's prostatectomy, we did a cystotomy for drainage.

Twenty days later the patient was in satisfactory condition for the removal of the gland. At operation, the gland was found to project in all quadrants to a considerable degree. Enucleation was simple and a very large gland was enucleated in one piece. The picture at operation was that usually observed and the technic of the operation presented no unusual features. The patient made an uneventful recovery and has remained well.

Case 3.—Physician, aged sixty-eight, had symptoms of obstruction for several months. He was operated upon by Dr. Hugh Cabot, September 20, 1915, by a one-stage suprapubic prostatectomy. (The patient was then fifty-three years of age.) He had a severe attack of phlebitis following operation and had to use crutches for several months. In 1918, practically three years after prostatectomy, the patient had a perforating ulcer of the stomach which was successfully operated upon by Dr. Samuel Mixter. For several years the patient has suffered from myocardiac attacks and has been under the care of Dr. Paul White.

In December, 1929, approximately fourteen years after the prostatectomy, he had acute retention of urine and entered the Day-Kimball Hospital in Putnam, Connecticut, where he was catheterized by Dr. Overlock, who found that he had 40 ounces of residual urine. At that time it was learned that he had had symptoms of prostatism for a few months only. The cardiac distress, which was frequent and severe, was the explanation given by the patient as a probable reason for his not complaining of the bladder disturbance before the retention.

The patient was referred to us by Dr. Overlock, January 15, 1930. Residual urine was 20 ounces infected, and urinalysis gave evidence of chronic renal disease. There was a moderate sized benign prostate by rectal examination. Cystoscopically, there were considerable middle lobe and moderate sized intravesical lateral lobe projections. The musculature was thin, the left

ureteral orifice was gaping and the right ureteral orifice was not seen. The rectal palpation did not give a true idea of the size of the gland, which was largely intravesical in its regrowth. The cystoscopic picture was typically that of a benign prostatic hypertrophy. He was placed on urethral drainage and the bladder decompressed.

The patient was not subjected to prostatectomy again because of the cardiac condition, which was considered too severe to make operation advisable. Besides the defective circulation, his urinalysis, blood chemistry and renal function tests were poor. Fortunately, a catheter entered the bladder easily. The patient was placed on urethral catheter drainage and bladder lavage for about two weeks and then returned home. A report from this patient dated April 19, 1930, states that he is "seeing some patients in his office but continues to be very weak and has a lot of dyspnea." His doctor stated, May 9, that he still has a "moderate" residual urine.

Case 3 has been included because it is a typical recurrent prostatic hypertrophy and operative indications would be definite were it not for the other physical defects which render it inadvisable.

As previously stated, the object of this communication is not only to place these three patients on record but also to establish, as far as possible, a proper idea of the probability of recurrent prostatic obstruction following prostatectomy, by an expression from this Society regarding the matter.

BIBLIOGRAPHY

BAZY, P.: Bull. Acad. de med., Paris, 1927, xcvii, 843.

BLUM, V.: Ztschr. f. urol. Chir., Berl., 1920, v, 77.

CASARIEGO: Rev. espan. de urol. y dermat., Madrid, 1924, xxvi, 254-256.

CASPER, L., Berl. klin. Wchnschr., 1911, xlviii, 1500.

FREUDENBERG, A.: Verhandl. d. deutsch. Gesellsch. f. Chir., Berl., 1907, iv, 36 Kongr. 6, Pt. 1, 182-183.

FRONSTEIN, R., and MESCHEBOWSKI, G.: Ztschr. f. urol. Chir., Berl., 1926, xx, 222-229.

HEDINGER: Cor. Bl. f. Schweiz. Aerzte, Basel, 1906, xxxvi, 277.

HONEGGER, R.: Ztschr. f. Urol. Leipz., 1922, xvi, 425-440.

LEWIS, BRANSFORD: Jour. Urol., Sept., 1930.

LOUMEAU: Gaz. hebd. d. sc. med. de Bordeaux, 1912, xxxiii, 437-439.

LUMPERT, E.: Cor. Bl. f. Schweiz. Aerzte, Basel, 1911, xli, 99-102.

ORTH, O.: Ztschr. f. urol. Chir., Berl., 1921, viii, 83-86.

TAKAHASKI, A.: Ztschr. f. urol. Chir., Berl., 1927, xxii, 167-169. Urol. & Cutan. Rev., St. Louis, 1928, xxxii, 597.

TANDLER, J., and ZUCKERKANDL, O.: Berl., 1922, J. Springer, 130 p., 40.

VON ILLYES, GEZA: Ztschr. f. urol. Chir., Berl., 1925, xvii, 229-242.

YOUNG, H. H.: Johns Hopkins Hosp. Rep., Balt., 1906, xiv, 1-476.

SOME OF THE RENAL COMPLICATIONS OF PROSTATISM

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This paper was suggested to the writer by four recent cases. Two of those were cases referred because of right sided kidney and ureter pain with practically no symptoms referable to the bladder or the act of urination. In both of these cases there were present prostatic hypertrophy and fibrosis, with four and three ounces, respectively, of clear, sterile, residual urine, and further investigation revealed a definite hydronephrosis and hydro-ureter on the affected side, the symptoms of which were entirely relieved by suprapubic prostatectomy. The other two were cases of fibrotic prostates, both patients presenting the usual story of prostatism with grossly infected urine, having been subjected to a somewhat unsatisfactory attempt at suprapubic enucleation. Each of these patients because of continued inability to empty their bladders were later subjected to transurethral punch operations and still later to a second suprapubic operation for the purpose of removing further bits of prostate and fibrotic tissue. In each instance it became necessary during the course of a stormy convalescence to do a nephrectomy for gross cortical infections, one of them apparently hematogenous in origin. The cases will be reported somewhat in detail a little later. These cases have suggested that unilateral kidney lesions occur perhaps a bit more commonly than we suppose in cases of prostatism.

They also suggested several problems well known to everyone, some of them, as far as I know, not entirely solved to the satisfaction of anyone. This paper does not make any pretense of solving them but rather to present a few clinical observations and autopsy notes which might have a bearing upon them.

These problems might be grouped under three headings, all very closely interrelated:

1. The nature and degree of renal damage noted in cases of prostatism.

2. The nature and degree and mechanics of pelvic and ureteral dilatation from mechanical obstruction.

3. The nature and route channel of the renal infections so commonly seen in these cases.

These problems are difficult to solve. In fact, by their very nature, I doubt if all of them will be entirely solved beyond any question or doubt. The extensive discussion and varying views on the relative importance of ascending infection as compared with infection by way of the blood stream and lymphatics is an apt illustration of the difficulties encountered. Considerable light might be shed upon the mechanical problems involved by careful cystoscopic studies, including urograms of the kidneys and ureters of these patients before and after operation. So far as I know this is not commonly done and it is, of course, debatable whether or not it should be done—whether the information obtained would be of sufficient value to warrant the discomfort and, perhaps, risk incidental to the procedure. At any rate I doubt if, at the present time, any clinic could present sufficient data to be of any great statistical value. I have no doubt that the recently introduced intravenous pyelography may find a very definite field in this group of cases.

It seems fair to postulate that nearly all cases of prostatism present some degree of renal insufficiency. It seems fair also to assume that there are at least three factors responsible for this:

1. The cardiovascular changes so common in men at the prostatic age and of which the prostatic disease itself may well be an expression; in other words a true vascular renal disease.

2. Infection which may be in the form of an ascending infection either directly through the urinary channels or indirectly by way of the lymphatics or via the blood stream. It is my belief that either of these types may exist alone or together, with one or the other preponderating.

3. Simple mechanical back pressure, with or without infection.

Dilating a little on each of these: It is my belief that the

primary vascular changes are of more importance than is ordinarily assumed. This view is based in part upon a considerable number of autopsies performed at The Brooklyn Hospital in the past two years upon patients dying from various forms of cardiovascular disease. These autopsies included a large number of cases (60+) who had no clinical evidence of prostatism nor any gross postmortem evidence of urinary obstruction. The postmortems included a careful histological study of the prostates and in nearly every case there was noted a marked dilatation of the follicles at the periphery with definite retention of secretion and other changes which are always present in all stages of benign prostatic obstruction.

The observations thus far made in this study would seem to indicate that the basic changes in the prostate responsible for urinary obstruction are mainly vascular in origin and a local expression of general vascular disease; that they are not primarily of infectious or inflammatory origin, as appears to be generally believed, but that such inflammatory processes as appear in a fair number of the cases are secondary developments.

A complete account, including figures and conclusions, will be published later by Drs. McKenna and Denton of our staff, who are engaged in this study. Suffice it to say that the data so far at hand would seem to lend some weight to this conception of the disease. The argument should be equally cogent from another angle and on this basis we might fairly assume that cardiovascular disease is a definite part of prostatism to a greater degree than might be explained by the age incidence. It is of further interest to note in this connection that a considerable proportion of those cases admitted as cases of prostatism and dying either with or without operation presented definite clinical and autopsy evidence of cardiovascular deaths.

The matter of infection in its various types and modes of expression is of great interest. Most of our cases come to us with infection already present and practically all become infected before we are through with them. Young in his textbook carefully analyzes 1,000 cases from various angles. Speaking on infection he reports that of 209 patients who had never used a catheter 73 per cent were infected, of 229 who had used a

catheter occasionally 84 per cent were infected, and of 297 who used a catheter frequently 90 per cent were infected. It might be of interest to note how many of those who come to us with clear urine continue free from infection after operation and how many who are already infected wind up eventually with clear urine. Unfortunately I have no exact figures on this, but it is my impression that, while all of the uninfected patients pass through a period of infection, a considerable proportion of them eventually clear up entirely, and that comparatively few of those who present themselves with cloudy urine ever entirely clear up. I have undertaken to treat a few, perhaps a dozen, of these patients following prostatectomy, in which the bladder result was perfect but in whom the pyuria and pyelitis persisted. Repeated pelvic lavage and instillations produced, as far as I could see, very little or no effect upon the character of the urine. I was convinced that in these particular cases I was dealing with a pyelonephritis and my local remedies were not getting anywhere near the seat of the trouble. I have no doubt that some of these patients have a simple pyelitis. These are the cases that clear up following operation and I can understand how their ultimate complete recovery might be hastened by local treatment of the kidney pelvis and ureter.

Cases 3 and 4, particularly Case 4, are an illustration of what might be interpreted as two separate infection entities going on simultaneously in the same kidney, perhaps independently of one another. In Case 4 we have a definite unilateral hydro-ureter and hydronephrosis with a kidney pelvis only mildly infected, if infected at all, and at the same time a vicious cortical infection with an entirely different organism practically destroying the kidney and threatening his life. This latter I have assumed was hematogenous in origin although I know no way of proving it.

The matter of back pressure and mechanical obstruction present a few problems which are not entirely clear. While I have no doubt that in the majority of cases the mechanics are very simple and that it is merely a matter of an overdistended bladder which provides the obstruction, Cases 1 and 2 suggest that the problem is not always so simple. In both of these cases there was a frank intrusion of one prostatic lobe and the formation of heavy fibrotic bars in such a way as to distort the trigone,

doubtless disturbing the relation of the various muscle bundles of the bladder neck and base to the end that one ureter was grossly obstructed at its entrance into the bladder, while the other was not. In each of these cases there was a relatively small amount of residual urine. In each instance it was kidney pain that brought the patient to his doctor and in each instance complete relief followed suprapubic prostatectomy. In line with this clinical observation there were two autopsies in our group upon patients having prostatism who died in our hospital, in which the kidney and ureter on one side were enormously dilated, the kidney being converted into a mere shell filled with pus, while the opposite kidney and ureter presented no gross evidence of damage. The fact that unilateral hydronephrosis may occur as a symptom of early prostatism would appear of some clinical importance.

As I said at the outset, this paper presents problems and does not solve them. Some of these problems appear to me at least a bit obscure and not without interest. Perhaps more careful cystoscopic studies of our patients before and after operation, if done in sufficient number to be of statistical value, might be of interest. The appended case reports present the problems perhaps better than does the paper.

Case 1.—A man of sixty-three was admitted to the Brooklyn Hospital, February 6, 1928, with the following history:

He had been in excellent health until four months before admission, when he developed a dull aching pain referred to the right loin and groin. This had continued more or less constantly and was getting a bit worse in the last few weeks. On a few occasions he had had a mild colicky attack of pain lasting for a few minutes but never severe enough to require morphin. He had had no disturbance with his bladder function except that for the past few weeks he had been rising once at night to urinate. He explained this by the fact that he had been advised by his family doctor to drink large quantities of water. The voided urine which he passed with a fairly good stream was clear, free from abnormal elements and sterile on culture. There were, however, 4 ounces of residual urine. General physical examination was negative except that the right kidney was palpable, seemed a little large and was definitely tender to palpation and deep percussion. Rectal examination showed a prostate apparently about normal in size. Cystoscopy, February 7, showed a moderate intra-urethral intrusion and what appeared to

be a heavy bar extending particularly up toward the right side of the trigone; there was quite a deep bas-fond and there were a few minor trabeculations. The mucous membrane was otherwise normal. The ureter orifices were normal and were easily catheterized to the kidney pelvis with No. 5 catheters. The flow of urine appeared in fairly normal rhythm for each side, a little more rapidly on the right. Both urines were clear and showed a few red blood cells

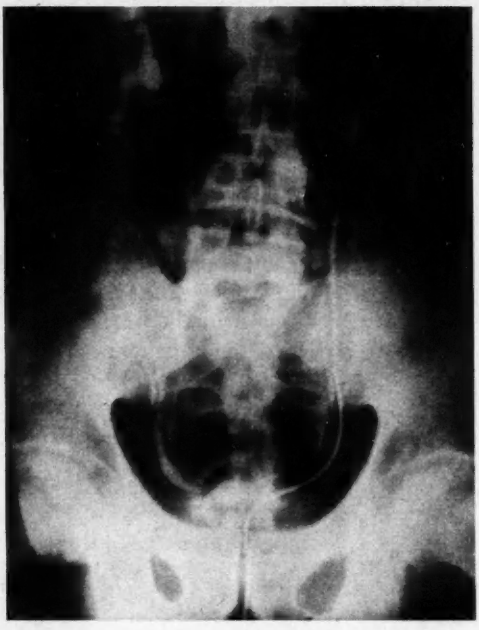

Fig. 1. Case 1. Moderate dilation of right ureter. Right kidney somewhat enlarged.

and white blood cells on each side, probably due to trauma, and they were sterile. The phenolsulphonephthalein output was equal on the two sides and slightly below normal. A right sided pyeloureterogram was made using 7 c.c. 15 per cent solution sodium iodid for the pyelogram and 3 c.c. for the ureter. The X-ray was negative for calculi. Both kidneys were a little large and low. The right kidney pelvis was rather large but showed a clear definition of the minor calices; the ureter was moderately dilated throughout

(Fig. 1). Seven minutes after the injection most of the medium was still retained in the pelvis and ureter (Fig. 2).

Other laboratory data were as follows:

Blood chemistry showed urea, 30.6; creatinin, 3.11; sugar, 108.6. CO_2 combining power was 49.7. Wassermann test was negative.

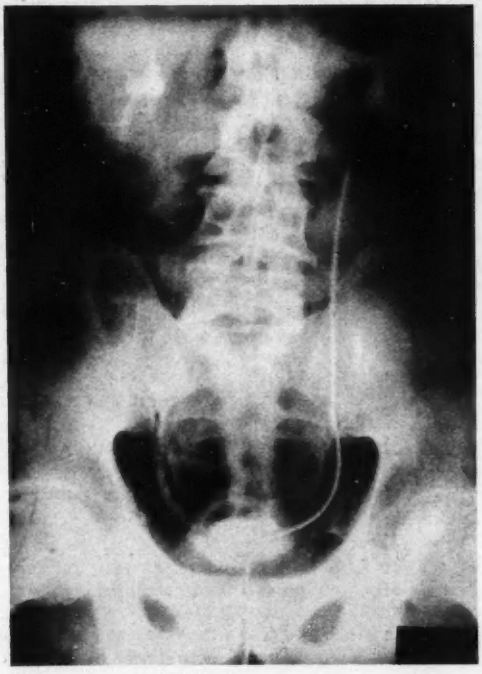

Fig. 2. Case 1. Seven minutes after injection showing almost complete retention of pyelographic medium.

Coagulation time was 7 minutes. Group IV. The phthalein test showed 25 per cent the first hour and 30 per cent the second hour.

Suprapubic cystotomy was performed on February 10 under local anesthesia. The bladder wall was very slightly thickened. The internal sphincter was very tight and there was a dense heavy bar extending across the posterior lip of the ureters which could be followed well up on the right side of the trigone, extending nearly to the ureter orifice. The prostate appeared only slightly enlarged. The second operation was performed two weeks later under sacral-

parasacral and field block anesthesia. The previous wound was rather widely re-opened. The internal sphincter was widely divided, making a definite tear which appeared to run naturally along the line of the band upward and to the right. Two small pieces of prostate, each about 1x1.5x3 cm., were enucleated with some difficulty and in addition several bits of the fibrotic bar were removed with a punch forceps.

The pathological report was briefly as follows:

Sections of the prostate showed obliteration of the ducts by amyloid bodies. There was marked fibrosis of the peri-urethral part of the gland and distention of the gland alveoli by secretion.

The patient made an uncomplicated recovery and left the hospital on March 20, twenty-four days after operation. At this time he was voiding slightly hazy urine in a good stream at normal intervals. The right sided pain was much improved but was still present. The cloudy urine persisted for about a month, when it became clear. A mild right sided ache persisted, although gradually diminishing for another month, at which time it had entirely disappeared. I have seen the patient at intervals since and he remains perfectly well.

Case 2.—This patient was seen about one year later and was almost an exact duplicate of Case 1 and will, therefore, not be cited in detail. Both of these cases, of course, had a moderate degree of bladder-neck obstruction, which would undoubtedly have become progressively worse. The point of interest, however, is that each of them sought relief for kidney and ureter pain, which was produced by obstruction at the intramural portion of the ureter brought about by the development of fibrotic bars in and about the prostate and trigone and that each patient was entirely relieved of his symptoms by a somewhat atypical suprapubic prostatectomy.

Case 3.—K., a man of sixty-two, was first seen February 16, 1924, complaining of frequent and sometimes painful urination for the past three months, with acute retention. Six days previously there had been complete retention, since which time he had been catheterized twice daily. The catheterizd urine was loaded with pus cells and showed bacillus coli in culture. Rectal examination showed a moderate regular prostatic enlargement. Cystoscopy was not done. His general condition was good.

Blood chemistry showed: Urea, 45.6; creatinin, 2.1; phenolsulphonephthalein, 1st hour 20 per cent, 2nd hour 25 per cent.

X-ray showed a rather large left kidney, otherwise negative. A catheter was put in the bladder for six days, at which time a suprapubic cystotomy was performed under field block anesthesia. The bladder wall was moderately thickened, there was a moderate intravesical prostatic enlargement and the internal meatus was very tight.

Seven small calculi were removed. These were not noticed on the X-ray film previously made. Chemical examination showed them to be comprised of calcium phosphate.

Suprapubic prostatectomy was performed, March 3, 1924. The size of the prostate was materially diminished and two small pieces were removed with great difficulty. We felt that we had not made a very satisfactory operation. Sections of the pieces of prostate removed showed a predominance of fibrosis, no evidence of malignancy. The patient made a rather slow recovery and left the hospital, April 25, 1924, with a little urine still draining occasionally from his sinus.

This continued for a few weeks after his return to his home. His frequency persisted and he still had 5 ounces of very cloudy residual urine, which was very little if at all improved by repeated bladder washing. Cystoscopy in April, 1925, showed two small calculi in the bladder. These were removed by litholopaxy with some improvement in the frequency but the character and amount of residual urine remained the same. He went to the country for the summer and reported on his return in the fall that his condition had remained about the same. In October, 1925, a transurethral punch operation was performed, removing two good sized pieces of fibrotic tissue with a Caulk cautery punch. There was a little improvement following this and the amount of residual urine was reduced to 3 ounces.

On December 15, 1925, the patient was re-admitted to the hospital, complaining of feeling generally ill, pain in his left loin and marked frequency and dysuria. He had a moderate pyrexia and the left kidney was definitely enlarged and tender. We made a diagnosis of left pyelonephritis and placed him on the usual conservative measures. He appeared to improve for a while and then became definitely worse, his temperature ranged higher and he looked and was rather profoundly septic. On December 28, 1925, cystoscopy was again performed and the ureters catheterized. The urine from the right side was clear, sterile and showed a normal phenolsulphonephthalein output. No urine at all could be obtained from the left side. Operation was decided upon and the following day a left nephrectomy was done. The kidney was about three times the normal size, the pelvis was moderately dilated and the cortex was riddled with abscesses so that no vestige of kidney tissue was apparent. Culture from the pus showed bacillus coli.

It is interesting to note that the X-ray showed an enlarged left kidney preceding the original operation about two years before. The patient undoubtedly had a grossly infected hydronephrosis at this time, which had become progressively worse. It is my impression that at the time of his recent febrile attack the infection extended into the cortex by way of the renal lymphatics, where finding

a more fertile field it took on added virulence which led to rapid and complete destruction of the entire kidney. This is, of course, only a supposition but it seems a reasonable one.

The patient made a prompt recovery and left the hospital in two weeks in good shape but still complaining of considerable frequency. He passed out of my observation for a while and did not report again until November 25, 1926. At this time he reported that he had been fairly comfortable until two months previous, when his frequency and dysuria became rather more troublesome. This state of affairs had been rapidly growing worse until at the time he was obliged to urinate every fifteen minutes, each time with great pain. Cystoscopy was attempted but was entirely unsatisfactory because of pain, cloudy medium and inability to introduce enough of it into the bladder.

He was again admitted to the hospital and a cystotomy was performed, November 27, 1926. We were much surprised to find a soft calculus almost entirely filling the bladder. It was about the size of a large orange and the consistency of soft putty. This was removed and at the same time a small nubbin of prostate, which protruded from the right lip of the internal meatus was also removed, twisting it out with ordinary sponge forceps. Following this operation the patient made a very prompt recovery and left the hospital in three weeks with the wound entirely healed. I have seen him at occasional intervals up to the present time. He remains well. The urine is hazy and contains a moderate number of pus cells. He voids in a good stream at normal intervals and has no residual urine. This case would appear of some interest aside from the subject under discussion because of the multiplicity of operations and the soft calculus removed at the last operation.

Case 4.—This patient was a man of sixty-seven, who presented himself for examination and treatment, November 23, 1928. He had had considerable frequency for the past twenty years but much worse during the last year. He voided in a very feeble dribbling stream about every two hours night and day. Eighteen months before he had had a complete nervous breakdown and was obliged to retire from business. He had always used tobacco and alcohol to excess. His general appearance was that of a feeble old man. Reflexes were normal. The prostate by rectum was moderately enlarged and there were 8 ounces of very cloudy residual urine, which showed staphylococcus albus on culture. He was referred to the hospital and following a week of catheter drainage a suprapubic cystotomy was performed, December 7, 1928. The bladder wall was moderately thickened; no calculi, tumor or diverticula were found; there was a moderate intravesical and intraurethral prostatic enlargement and there was also noted a fairly heavy fibrotic bar

extending across the upper part of the trigone and apparently separate from the prostate.

The laboratory findings at this time were as follows:

Blood chemistry showed urea, 48.6; creatinin, 2.69; sugar, 101. Coagulation time was 6 minutes. Group IV. Phenolsulphonephthalein was 15 per cent first hour, 20 per cent second hour. Concentration test showed variation from 1003 to 1015. Hemoglobin was 63 per cent.

On December 21, 1928, a suprapubic prostatectomy was done; a fair sized prostate was readily enucleated. The heavy interureteric bar was again noted and nothing was done about it. It was my feeling at the time that with the prostate removed the patient should empty his bladder reasonably well. The pathological report on the sections showed a dense fibrosis and involution of the prostate.

He left the hospital in eighteen days with the wound entirely closed. While the amount of his residual urine was reduced to 3 ounces, the frequency and the character of the stream remained about the same. In March a transurethral cautery punch operation was performed with little or no improvement in the condition. He continued much the same through the summer and reported in the fall, very unhappy and thoroughly dissatisfied. At this time he had 4 ounces of residual urine.

Cystoscopy, September 24, 1929, showed bladder neck clear but the same old bar was very much in evidence. I advised another cystotomy and excision of the bar. This was for the moment declined. On October 15, 1929, he was seized at his home with a very typical and severe right renal colic, requiring morphine for its relief. There was no elevation of temperature. I assumed that he had a small calculus finding its way down the ureter and that he would probably pass it spontaneously. Following the subsidence of the acute pain there remained and persisted a definite soreness referred to the right loin and the kidney was palpable and tender. He was readmitted to the hospital in November. The X-ray was negative for calculi but showed the right kidney moderately enlarged.

Laboratory findings at this time were: Blood chemistry showed urea, 35.6; creatinin, 1.64; sugar, 87.7. CO_2 combining power was 67.1. Phenolsulphonephthalein, 20 per cent first hour, 25 per cent second hour. Concentration test was 1003 to 1015. Hemoglobin was 78 per cent.

The bladder was reopened November 22, 1929, and the bar very freely excised. Two days following operation there was a sharp rise of temperature with considerable pain and tenderness over the right kidney. The temperature gradually subsided following forced fluids, alkali and colonic irrigation but the pain and tenderness persisted. In spite of this the suprapubic wound healed and the patient left the hospital in four weeks.

He was seen again January 6, 1930. His frequency was about the same, the stream was a little better and the residual urine was now 2 ounces. Three days later he had a very severe exacerbation of right renal pain accompanied by high fever and a leukocytosis of 25,000. He was again admitted to the hospital and a cystoscopy was done two days later. No. 5 catheters were passed to each kid-

Fig. 3. Case 4. A low right kidney with moderate hydronephrosis. There is no X-ray evidence of gross renal destruction.

ney pelvis. Clear urine flowed in normal rhythm from the left, in a slow steady stream from the right. There were numerous leukocytes in the urine from the right kidney, no abnormal elements in that from the left side. *Both were sterile to culture.* There was a normal phenolsulphonephthalein excretion on the left side. It was zero on the right. The X-ray showed a low, large right kidney. The pyelogram showed a moderate degree of hydronephrosis (Fig. 3).

These findings rather obscured the diagnosis and the indications for treatment. The patient was observed for a few days, during which he obviously became sicker and more definitely septic so that

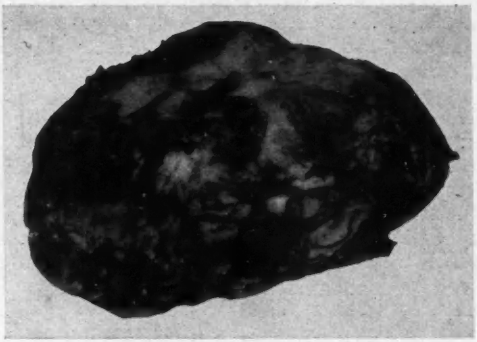

Fig. 4. Case 4. Gross appearance of kidney removed.

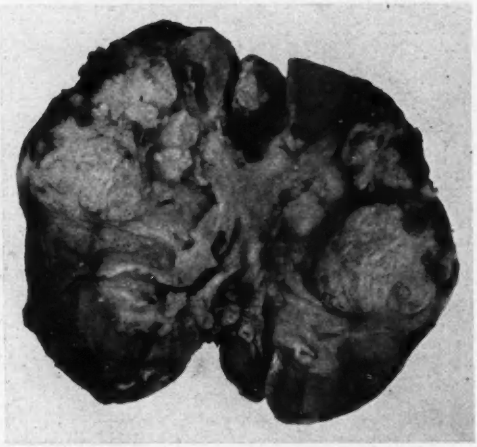

Fig. 5. Case 4. Same kidney bisected, showing gross infection and destruction of kidney.

nephrectomy was decided upon and performed, January 17, 1930. Going through the muscle layers we opened into an abscess cavity containing about 2 ounces of pus which showed staphylococcus

aureus on culture. The kidney was buried in a dense mass of inflammatory adhesions. The true capsule was incised, evacuating another small collection of pus, and a subcapsular nephrectomy was performed. On section (Figs. 4 and 5) the renal cortex was found entirely destroyed with numerous large and small abscesses apparently not communicating directly with the pelvis. The patient had a very stormy time for a week following operation but finally rallied and went on to a very slow and very protracted convalescence, complicated by bed sores and a suprapubic fistula which opened and closed several times. Cystoscopy on March 11, 1929, at which time the fistula was still leaking a little, showed no evidence of bar or any obstruction at the bladder neck. The bladder wall appeared very flabby and the fluid medium had to be expressed manually.

At present writing (March 16, 1929) the patient is still in the hospital, up and walking about with an indwelling catheter in his urethra.

The points which I particularly wish to stress in this case are: the sound left kidney, the right hydronephrosis only slightly infected, if at all, and the complicating cortical infection which would appear to have been introduced as an entirely distinct and separate clinical entity.

VASECTOMY IN PROSTATIC SURGERY

A REVIEW OF 141 CONSECUTIVE PROSTATECTOMIES

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A review of the literature shows that prostatic hypertrophy in its treatment has been studied from two general broad lines of consideration: (1) sex surgery based on the effect of the testicles upon the development of prostatic obstruction: (2) mechanical means for the removal of such obstruction once it took place. In this discussion we shall consider vasoligation only in the light of the second broad division, the mechanical means for relief of epidymitis associated with prostatic obstruction.

Inasmuch as vasoligation has become an institution in surgery, as much because of sex surgery as it has as a preventative of epididymitis, the development of the operation and our knowledge of the influence of ligation upon the testicle has a common birthright. It will, therefore, be necessary to review sex surgery only as it has aided in developing vasoligation.

A review of the literature indicates that somewhere between 1896 and 1904, vasoligation as a preventative for epididymitis first came into use. Proust[20] in his book, "La Prostatectomie," and Albarran[1] in 1909, in "Medecine Operatoire des Voies Urinaire," mention the use of vasectomy as a preventative for epididymitis in prostatic surgery. These authors, however, had only a short paragraph in discussion of the subject, and a perusal of the book seems to indicate that it was more thought about than employed. Moore in discussion of McKay's[14] article (1929) on vasoligation quotes Judd (1911) who did fourteen cases of bilateral vasoligation in prostatectomy. He, however, discontinued the procedure. The reason for this change is not clear. It was not until 1927 and 1928, when, following discussion of the subject by Goldstein[10] and the following year by Alyea,[2] that vasectomy attained its present wide usage as a procedure in pros-

tatic surgery. To these authors should be given credit for popularizing vasectomy as a preliminary to prostatectomy.

Historically the procedure has attracted attention since the writing of an article by Cooper[7] in 1845 in which he reported

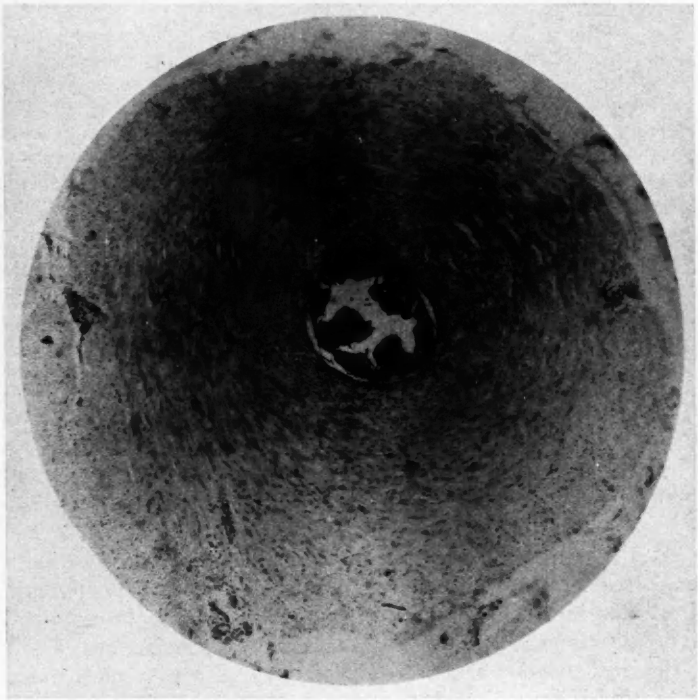

Fig. 1. Normal vas. X46.

unilateral vasectomy in a dog. Six years later examination of the epididymis showed that this organ was distended with spermatozoa which had been retained since the occlusion of the vas. Gosselin[11] (1853) did vasectomy in two dogs. He found the testicles normal six and ten months later. Curling[9] (1866) in his book on "Diseases of the Testicle," Philadelphia, reported four experiments of vasoligations in which the sperms were found

abundantly present after the vasectomy which had been done from two to eight months previous to the examination. Considerably later, 1893, Birkett and Hilton[5] wrote on the subject of vasectomy with regard to the effect of this procedure on the

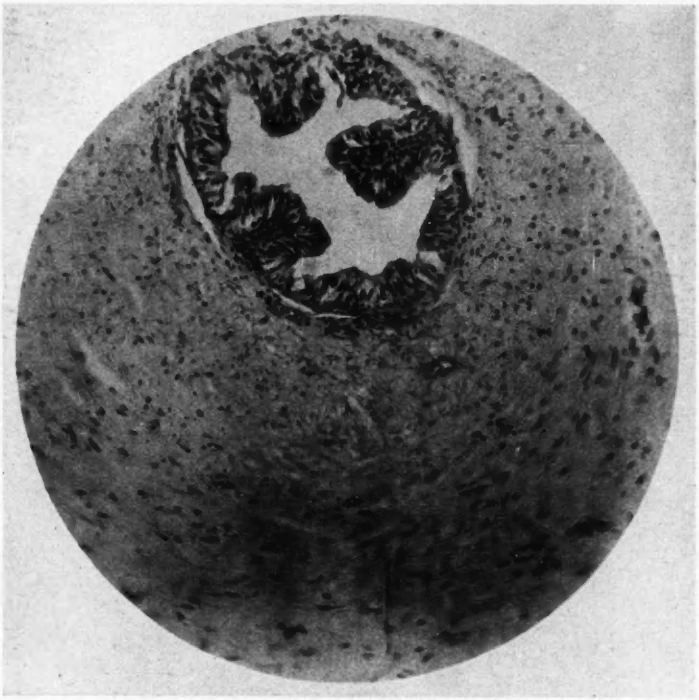

Fig. 2. Normal vas. X106.

size of the prostate. Werwath,[30] in an article published in 1928, ascribes to Lennander (1894) priority for vasoligation. He seems to have been the first writer in the German literature to have attempted to obtain prostatic retrogression by employment of vasoligation as a deterrent to prostatic growth. Guyon[13] (1885) is apparently the first of the French surgeons to advocate the use of vasectomy to produce atrophy of the prostate.

The idea that operations upon the testicle cause retrogressive change in benign prostatic hypertrophy seems to have been of short duration. More recent literature shows but few references indicating that it is still considered of any value. Pankratjew[12] (1900) reported 270 cases of bilateral resection of the vas in

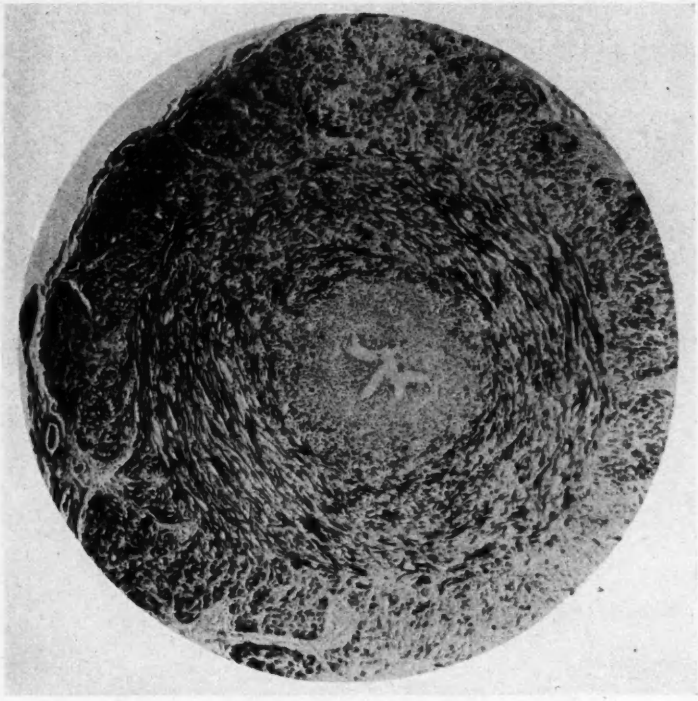

Fig. 3. Normal vas in acute inflammation. X46.

which 30 per cent seemed to have made sufficient improvement to make further operative intervention unnecessary. He states, however, that these cases were mildly improved. They were inoperable cases on account of high grade senility, severe lung or heart complication or irreparable kidney disease. Werwath[30] reporting eighteen cases of the same type in which he had done

vasoligation thought he could detect prostatic decrease on three occasions, yet he could not eliminate improvement due to constant drainage and catheterization as an element in this improvement. It seems to be sound judgment to assume that the day of the sex operation for influencing prostatic hypertrophy has

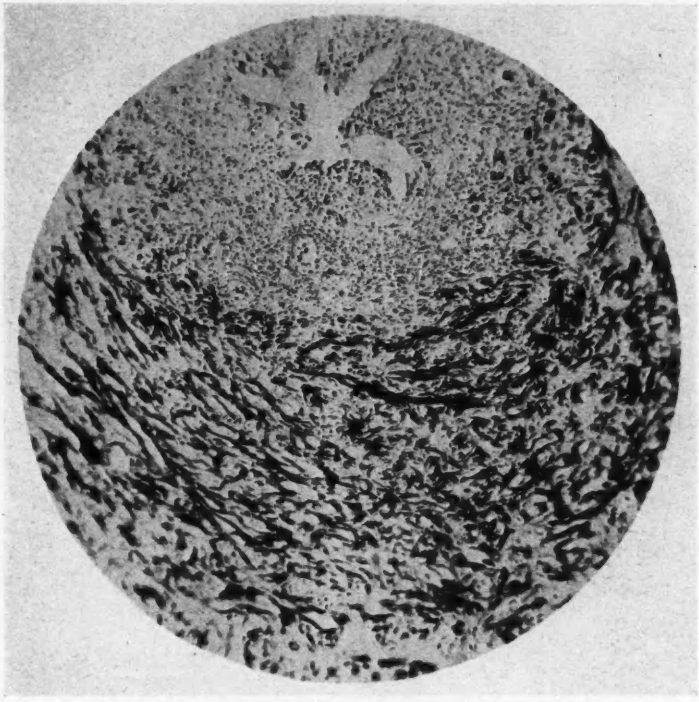

Fig. 4. Normal vas in acute inflammation. X106.

definitely passed, yet we must not forget that in some measure the data of experimental nature which are now available were produced by investigations concerning the usefulness and the effect upon the testicle of these endeavors.

EFFECT OF VASOLIGATION ON THE TESTICLE AND EPIDIDYMIS

The first observations on vasoligation, already referred to, performed by Cooper, Gosselin, Curling, and others, showed that

spermatozoa were present in the epididymis after vasoligation in animals as late as six years. Therefore, they concluded that no testicular damage resulted from vasoligation. Spangaro[28] in 1903 was able to demonstrate spermatozoa in the testicles but seemed disappointed that no degeneration of testicular substance

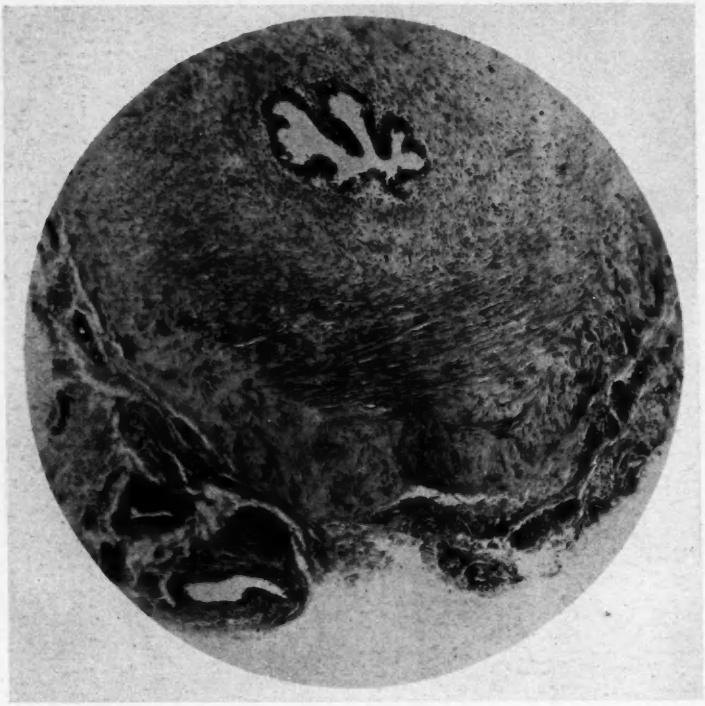

Fig. 5. Chronic vasitis. X46.

had been produced. Gregg[12] (1905) found the testicles perfectly normal four years after accidental vasoligation in herniotomy cases in man. Wallace[29] (1905) concluded from his vasectomy experiments on dogs that though there is some distention of the epididymis following vasoligation, there is no dilatation of the tubules, and that the growth of the testicle and its function of producing spermatozoa is independent of the integrity of the

vas. Oslund[18] (1924) experimenting on dogs concluded that vasectomy does not cause degeneration of germinal epithelium of the testicles, and Moore and Oslund[16] (1924) concluded from their experiments on sheep that vasoligation does not cause

Fig. 6. Chronic vasitis. X106.

degeneration of the epithelium of the seminiferous tubules. Oslund summarizes his observations on the subject as follows:

1. Following vasectomy the epididymis is usually distended and hardened by the accumulation of testicular products.
2. An equilibrium is quickly established between the rate of

production of testicular secretion and its absorption from the epididymis.

3. The establishment of such an equilibrium is a factor in preventing pressure atrophy in the seminiferous tubules.

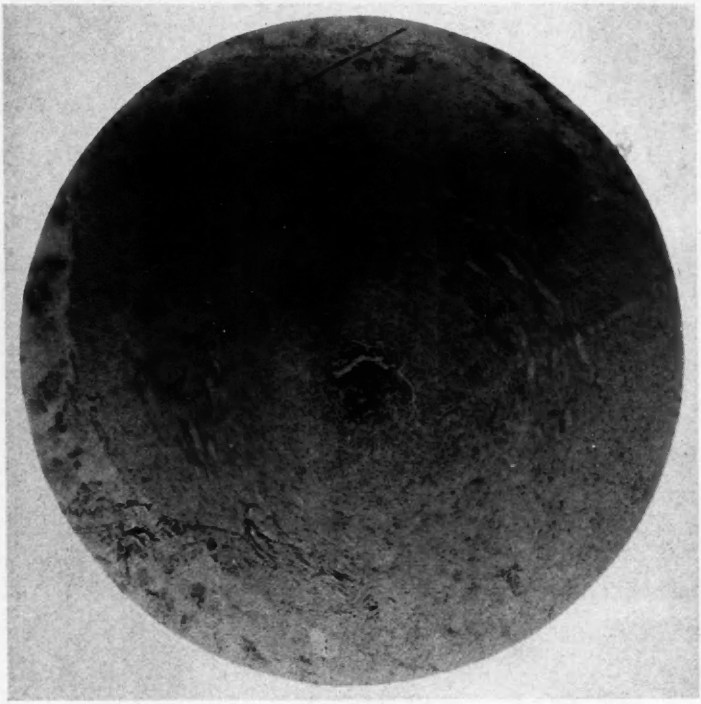

Fig. 7. Atrophic vas. X46. Low grade inflammation about the lumen.

4. Vasectomy in dogs for a period of two and one-half months following the operation has not caused degeneration of germinal epithelium.

5. In all testes following vasectomy the interstitial cells are normal both in quality and appearance.

6. From a review of the literature he has found no cases in which in man six months to four years following vasectomy there was any testicular change other than distention of the epididymis. He points to the error in the theory that vasectomy is a means of producing rejuvenescence.

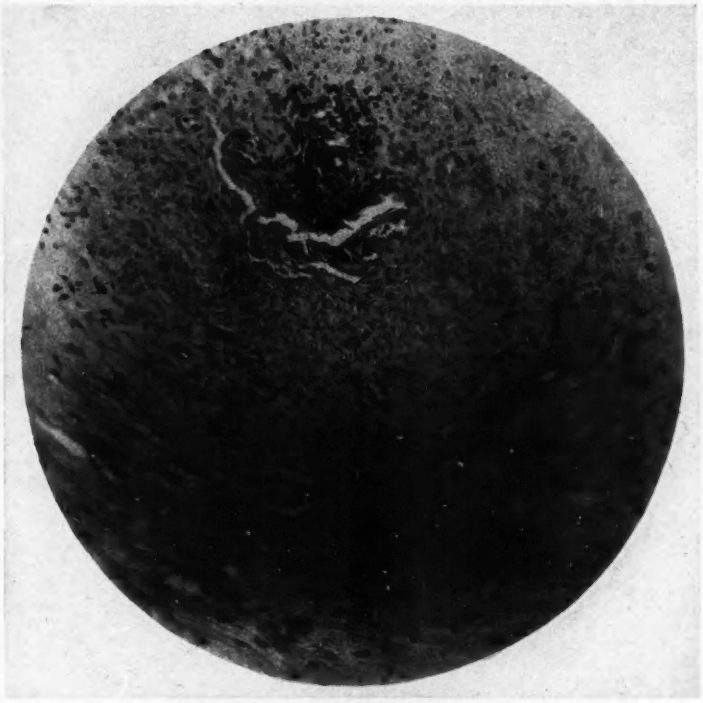

Fig. 8. Atrophic vas with low grade inflammation about the lumen. X106.

EFFECT OF VASOLIGATION ON THE GENERAL CONDITION OF THE INDIVIDUAL

Aside from the doubtful evidence produced by Steinach and his adherents, there is little evidence to show that there is any

effect upon the general condition of the individual produced by vasoligation.

Craig[8] (1928) stated that many years ago in his hospital twenty ligations for prostatic hypertrophy were performed. Five of these cases developed mania, an occurrence which dampened

Fig. 9. Chronic vasitis with superimposed acute process. X46.

enthusiasm for the procedure. Presumably these patients were not operated on or further relieved of their prostatic condition. Uremia was a possible factor in the production of the abnormal mental condition.

Match and Teagarden,[15] in experiments on animals (senile rats), noted that the effect of ligature of the vas as shown by their behavior in a circular maze as regards muscular coördina-

tion, efficiency and general behavior was negligible. A definite improvement, however, in muscular coördination, muscular efficiency and general appearance of the rat, but transient in nature, was noticed. Alyea[2] concluded from his observations that the sex life in man was unimpaired by vasoligation.

FREQUENCY OF OCCURRENCE OF EPIDIDYMITIS IN PROSTATIC SURGERY

The frequency of occurrence and the serious nature of the condition as regards added operative risk and postoperative comfort in years to come had not generally been appreciated by surgeons until recent statistical study has demonstrated the importance of this condition. It seems almost to have been taken for granted that epididymitis was a necessary evil in the performance of prostatic surgery. The common ill effects mentioned as resulting from the occurrence of epididymitis in the course of the patient's progress through the hospital in prostatic surgery are as follows:

There is no doubt that the rapid turn-over of a case is prevented by the continuation of the patient in hospital as a result of epididymitis. Along with this should be considered the increased cost to the patient of prolonged stay in hospital. There is no doubt that the occurrence of fever and pain which accompanies epididymitis has a debilitating effect upon the average patient. Often this occurrence overbalances a patient with a narrow margin and is actually responsible for a certain number of deaths in patients who might otherwise have passed through operation successfully. In addition, the occurrence of epididymitis at the time when the patient seems to have reached the end of a rather prolonged preparation and operation, has depressing mental and psychological effects in addition to depressing his general physiological condition. Mechanically, the occurrence of epididymitis with the necessary discontinuance of urethral drainage delays healing of fistulas in these cases. Also it interferes with the performing of urethral manipulations which may be indicated following operation because of the undesirability of such manipulation and dilatation during the course of epididymitis.

Scott[27] believes he has demonstrated the occurrence of pyemia

and subsequent death in cases in which epididymitis seems to be the exciting cause. The actual percentage of cases in which epididymitis occurred in the course of prostatic surgery, according to the reports of the authors contributing, has a wide variation ranging from 6 per cent in one group of reported cases to

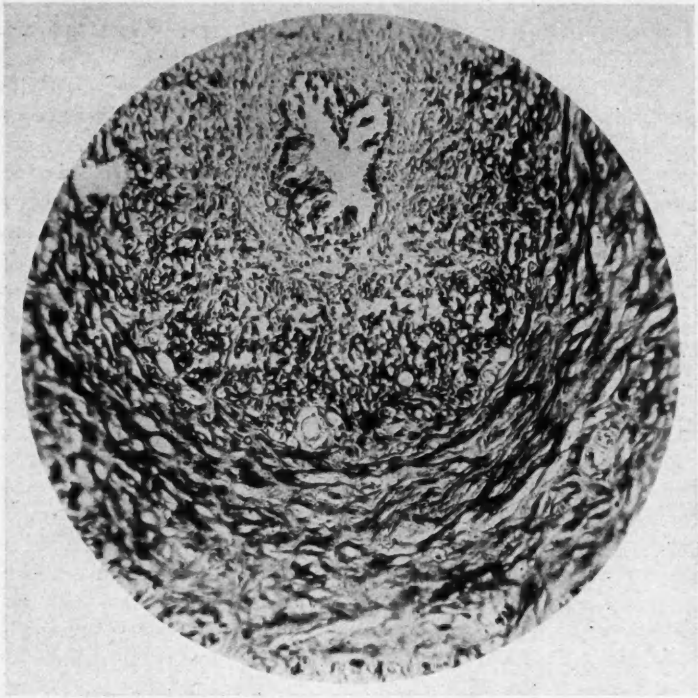

Fig. 10. Chronic vasitis with superimposed acute process. X106.

82 per cent in another. Undoubtedly, there are variant factors in the handling of these cases which contribute to the frequency of occurrence. There is also recognizable difference in the criteria for diagnosis as is easily noted in the report in which 82 per cent of the patients showed epididymitis. Yet in 1,624 collected cases available, with the exclusion of the two papers mentioned above, there is an average of 21.6 per cent of epididy-

mitis taking place during the patient's stay in hospital. This does not include the late development of epididymitis in the first few months after leaving the hospital or even years following the operation, which considerably increases this figure. Recently we have observed a patient suffering from the thirteenth attack of epididymitis in the seven years which had elapsed since the operation was performed, yet in this case there was no epididymitis in the course of the hospital stay. Recently a case has been noted in which the first attack of epididymitis occurred six years following operation. In these statistics there are few data as to the frequency of occurrence previous to operation, but a general agreement among observers that the commonest time for the occurrence of this condition is postoperative. In those instances in which preoperative epididymitis develops, the indwelling catheter has been pointed to as the chief factor in its production. Postoperative passing of sounds, cystoscope or other urethral instrumentation is frequently pointed out as likely to set up an epididymitis.

In regard to the occurrence of epididymitis in the various types of operations employed, Randall has pointed out that there is a higher percentage taking place in the previously uninfected cases, assigning as the cause acquired resistance to infection. There seems to be definite disagreement with the view that the incidence of epididymitis postoperatively is greater after suprapubic operation. It is to be remembered that the veru may be present in the specimen removed suprapubically and that scarring and obstruction due to damage to the ejaculatory duct must exist. White disagrees with this point of view and believes that the operation showing less postoperative epididymitis is the two-stage suprapubic prostatectomy. In the perineal operation, especially in those operations devised to preserve the ejaculatory duct, there is undoubtedly a slightly lower percentage of epididymitis than where the verumontanum is not preserved. In contrast to these figures are the statistics of Aschner,[8] who recorded in a series of 277 prostatectomies the following percentages of epididymitis: in those patients operated on by a one-stage operation, there was 10 per cent of epididymitis postoperatively; in the two-stage operation, he had 5 per cent of epididymitis preoperatively, 15 per cent postoperatively—for a total of 20 per cent. From

these widely variant figures it is to be deducted that there are not yet sufficient data in the literature to allow a very thorough and definite statement as to the percentage of occurrence preoperatively and as to the difference to be expected in the different types of operation employed.

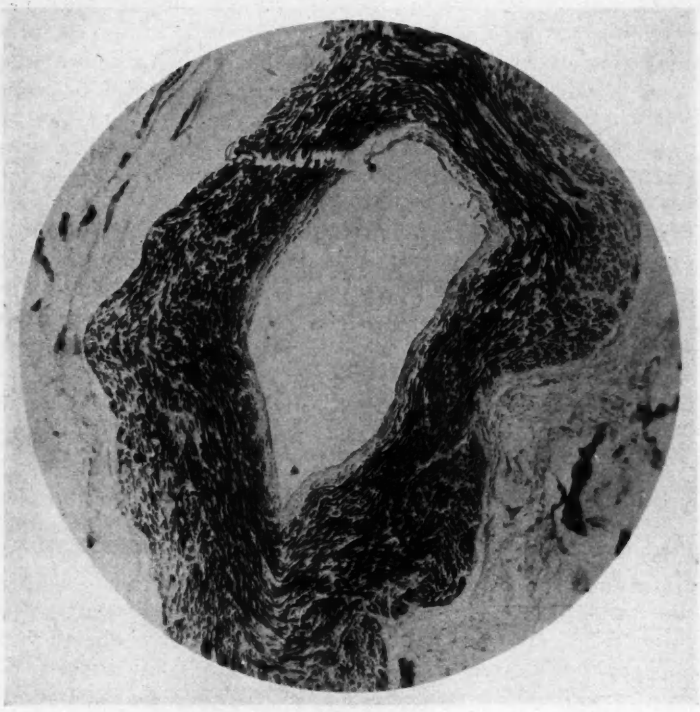

Fig. 11. Chronic dilated vas. X106.

ETIOLOGICAL FACTORS CONCERNED IN THE PRODUCTION OF EPIDIDYMITIS

One must not forget that occasionally patients are seen with epididymitis at the time they enter the hospital. This has resulted either spontaneously from a cystitis and prostatitis with extension of the infection to the epididymis or as a result of catheter life. Two factors should be mentioned here as probably con-

tributing to this condition. Treatment of prostatic cases which show some prostatitis by prostatic massage previous to their decision to undergo operation may produce preoperative epididymitis. It has also been mentioned (Keyes) that, as a result of straining at stool, infection may be forced from the vesicles down the vas to produce an epididymitis. The occurrence of a general urinary tract infection as a result of the institution of drainage in previously uninfected bladders involves the seminal vesicles in infection which is apt to result in epididymitis. According to Randall,[21] it is more apt to produce epididymitis in uninfected cases than similar treatment in a previously infected case. Infection is more serious in cases in which urethral drainage is instituted following trauma from attempt at catheterization. In these patients the urethra is bloody and traumatized and the accidental introduction of infection or the production of bleeding within the urethra is apt to result in urethritis which may extend into the vesicles and produce epididymitis. One might also mention in this regard the urethritis which seems to be more pronounced in those patients in which a catheter fits tightly into the small urethra, particularly in those patients having a small meatus. Such urethræ require more attention to keep the urethritis under control and seem to be more extensively involved in the necessary accompanying suppuration attendant upon inlying catheter drainage.

The largest factor to be considered in the preponderance of postoperative epididymitis over preoperative epididymitis, we think, must be ascribed to sepsis in the prostatic cavity after operation. In those operations in which ejaculatory duct damage has been produced, the openings of these organs minus the normal protective mechanism at the verumontanum is embedded in a septic and often sloughing cavity, ideal conditions for the extension of infection into seminal vesicles; the possibility of blood-borne infection becoming arrested in the epididymis because of its excretory function should be mentioned. We have found few data to indicate the relative importance of this mode of invasion, although it seems logical to assign it some rôle in the occurrence of epididymitis. There are no data available sufficient to allow the drawing of conclusions as to what part gauze pack, bags and other mechanical means to control hemorrhage play in the pro-

duction of vesicle and epididymis inflammation. Extensive loss of blood, producing lowered resistance, must be ascribed some importance as a factor.

Glycosuria has been mentioned as a factor in epididymitis because of the well-known lack of resistance to infection encountered in the patient with sugar in the urine. Perhaps this will no longer deserve prominent mention because the handling of diabetic patients no longer offers such handicaps as existed previous to the use of insulin.

Rathbun[22] has emphasized more than most authors the importance of instrumentation in the production of epididymitis. In his series of 100 consecutive cases there were two cases of epididymitis developing preoperatively which he ascribed in both instances to the indwelling catheter. The four postoperative cases of epididymitis which occurred in his series occurred in each case after the passing of a sound.

There are as yet few data except those presented in our series to show what part pathological conditions of the vas plays in the production of epididymitis. There is no doubt that abnormalities of the vas are frequently encountered. This will be shown elsewhere in this communication. Stricture, fibrosis with atrophy of the vas, and dilatation of the lumen of the vas are the usual abnormalities encountered. There is no doubt that in many of the instances in which epididymitis develops in patients who did not have it in the course of their hospital stay, scarring about the prostatic cavity, involving the remnant of the ejaculatory duct, plays a rôle.

PATHS BY WHICH INFECTION MAY REACH THE EPIDIDYMIS

The possibility of blood-borne bacteria reaching the epididymis independent of the vas and its sheath cannot be denied. There is definite evidence of such taking place. Bier,[4] who advocated vasoligation in the opposite testicle in operation for tuberculosis epididymitis as a preventative to involvement of the second testicle, found that in certain cases such second testicle involvement did take place. Scott,[27] who reports an epididymitis appearing on the sixth day postoperative, noted a positive blood culture on the same day on which the epididymitis appeared. The patient, however, recovered. Intramural extension, that is, extension either by the lymphatic or by direct continuity in the walls

of the vas, has also been noted but probably is of only occasional occurrence. Randall[21] in examination of the portion of the vas removed at vasectomy in one case was able to demonstrate the bacteria in the wall of the vas. Rolnick,[26] who, by means of injection of the tissues of the vas, believes he demonstrated a sheath about the vas, was of the opinion that the infection frequently traveled there. The rôle of the lymphatics in the transmission of infection intramurally has been emphasized by many authors, yet in sections stained for bacteria even though a vasitis exists, we have been unable to demonstrate the bacteria in the walls of the vas. It is, therefore, to be concluded that intramural extension of infection following prostatectomy is not the common mode of infection.

In the opinion of most observers the common mode of extension to the epididymis of an infectious process in or about the prostate and vesicles is by means of the lumen of the vas. In fact, the success of vasectomy in prevention of epididymitis almost demands that this be the common mode of transmission. It is also to be noted that where sepsis about the severed end of the vas takes place even though abscess formation may take place as in O'Neil's[17] case, extension of the infectious process to the epididymis is not the rule. This abscess formation undoubtedly opens up lymph channels, advantage of which seems not to have been taken.

BASIC PRINCIPLES FOR EFFECTIVE VASOLIGATION

The literature shows that operations have been designed for ligation of the vas without performing vasectomy. This has been done in some instances without incision, in others by exposing the vas through a short incision and performing the ligation with absorbable material, usually chromic catgut. Alyea[2] reported in his article on vasoligation that in a series of twenty cases in which open operation with simple ligation of the vas had been employed, two cases of epididymitis resulted. One of them occurred at the end of three weeks postoperative, and he believes was probably due to the failure of the ligation to interrupt the continuity of the lumen or perhaps to failure to ligate the vas. Colson[6] has advocated ligation of the vas through the skin without making a skin incision, silkworm gut being used as the ligating material. The experimental work of Rolnick[25]

seems to show conclusively that simple ligation of the vas is an inadequate procedure. In those animals in which simple ligation of the vas was done, sometimes accompanied by multiple incisions into its walls, the vas regenerated and re-established its lumen as early as twenty-two days postoperatively. Ligation with absorbable material is by no means a guarantee of interruption and even with non-absorbable ligating material the lumen regenerated in a certain number of instances. There is some clinical support to this contention.

Cases have been reported in which spermatozoa were encountered in the vesicles after simple ligation. We have seen one case in which simple ligation with No. 1 chromic catgut showed spermatozoa in considerable number in the secretions from the vesicles within a period of three months following the ligation. There is a little comfort, however, in the fact that during the period of ligation there is at least some protection, which undoubtedly accounts for a certain measure of good results following simple ligation without vasectomy. Alyea found that after simple ligation at time of operation he had a 10 per cent occurrence of epididymitis, which is less than half of the average occurrence of this condition without ligation or vasectomy.

In thirty-five cases reported by McKay, three patients had epididymitis on admission. The remainder were all treated by simple ligation without vasectomy. Five of these patients developed epididymitis in a short time following the removal of the ligature. Four were low grade epididymitis, but one was a fulminating condition which developed within four days following removal of the ligature. In this series of thirty-five cases, the figure for postoperative epididymitis was 15 per cent.

There is every reason to believe both from clinical experience and from the work of experimental observers that the open operation with removal of at least 1 cm. of the vas is imperative if we are to provide the patient with the greatest protection. In addition, it is imperative that the vas instead of a large thick-walled vein must be ligated. Experience has shown that the vas is sometimes missed. It is also necessary that the sheath of the vas should be included in the ligature. Tendency of the vas to regenerate in case the tie should become disengaged is much greater if the sheath is allowed to persist. It is important that

after the ties are placed on the vas and excision of a portion has been done, sufficient stump should be left to insure the integrity of the tie. There is no doubt that slipping of the tie must be held responsible for a certain amount of the scrotal wound sepsis which occurs in these cases.

Keyes has advocated the ligation of the severed ends of the vas side by side like a double barreled gun. The stumps are not brought to the surface of the skin. Other operators have implanted the severed ends into the skin. Rolnick's work has shown that occlusion of the vas does not occur when the vas is sutured into the skin or exposed outside the body for a number of days. It is also conceivable that from juxtaposition it is more easily possible under Keyes' method for continuity of the vas to be established after the ligatures have been absorbed. It is to be noted in this discussion that a marked similarity exists between vasoligation and the sterilization of the female by ligation of the tubes. In both instances complete occlusion, not simple section, seems to be the criterion for success of the measure. Reed and Morgan[24] ligated six cases with an incidence of three or 50 per cent epididymitis in seven to twenty-one days postoperative. In one patient orchidectomy was necessary and serial sections taken above and below the point of ligation showed that the lumen was narrowed but was not obliterated. Ravich and McKenna in discussion of a paper on vasoligation stated that they had abandoned vasoligation because the percentage of epididymitis seemed not to be influenced by the procedure, that the occurrence of epididymitis was practically that of the unligated cases.

We present a study of 141 prostatic cases in which bilateral vasectomy has been done at some period in the course of the operative treatment. One hundred and five were two-stage suprapubic operations, twenty were perineal operations, and sixteen were one-stage suprapubic operations. It is interesting to note what the condition of the urine was in these patients at the time of entrance into hospital. Sixty-four per cent of these patients showed infected urine, and seven patients entered the hospital with epididymitis. Seventy-seven per cent of the patients had had urethral manipulation in some form and 25 per cent were kept on constant drainage for various lengths of time previous to any

vasectomy. In our handling of these patients we have held that the welfare of the patient superseded in importance the time at which ligation was done. We mean by that, that in many instances where a patient arrived in the hospital in poor condition we have not hesitated to put him on constant drainage until sufficient improvement had taken place to allow our doing cystotomy. Vasectomy has been done in those instances at that time. In one instance the patient had been on constant drainage through the urethra for a period of twenty-eight days before ligation of the vas was done. Where a patient had led a catheter life, however, and had infected urine, we did vasectomy and cystotomy at the time of admission. Most of these patients were subjected to cystoscopic examination and had had cystograms done previous to cystotomy. Aside from the fact that seven patients entered the hospital with epididymitis, no preoperative epididymitis developed in this series. The occurrence of preoperative epididymitis is no doubt largely a question of management of the case. Frequent changing of catheters and the fitting of a catheter of such size as to allow urethral drainage around it are no doubt important factors in the prevention of preoperative epididymitis.

In this group of 141 prostates operated on by three types of operation after bilateral vasectomy had been performed, there were four cases in which epididymitis developed. These are of sufficient interest to justify more detailed discussion of the epididymitis and the type of operation employed.

In one of these cases a very old man was operated on by a one-stage suprapubic operation for channeling of a prostatic carcinoma. He was operated on after a long period of urethral drainage. Twenty-two days postoperatively he developed an epididymitis on the left side. This subsided without operation and the patient recovered.

A second patient was operated on by a two-stage suprapubic operation. The patient had been on constant drainage preliminary to the ligation of the vas and cystotomy. At the time of operation both vasa were normal. The pathological examination of the prostate removed showed hyperplasia of the prostate but no prostatitis. Nine days following operation, however, he developed right epididymitis. This patient suggests a hematogenous origin for the epididymitis.

A third patient entered the hospital with an infected urine. Cystotomy and vasectomy were done immediately. The sections

of the vas showed bilateral vasitis which was described by the pathologist as acute and chronic vasitis. Pathologically the prostate showed in addition to prostatic hypertrophy, chronic prostatitis and urethritis of the prostatic portion of the urethra. Seven days after prostatectomy he showed a bilateral epididymitis. The left side subsided, the right side progressed to abscess formation and orchidectomy was performed three weeks after the beginning of the epididymitis. The pathological report on this testicle was acute suppurative orchitis and epididymitis.

The fourth case was a patient operated on by a two-stage suprapubic operation after ten days on constant drainage preliminary to cystotomy and vasectomy. The convalescence was uneventful. The pathological report showed prostatic hypertrophy but no evidence of prostatitis. The pathological report on the specimen excised at the time of the ligation showed no evidence of the vas on either side. Sixty-four days following operation the patient developed a right epididymitis. We believe in this case failure to ligate the vas was responsible for the occurrence of epididymitis, and that this patient falls into the group in which, due to scarring in the prostatic cavity, infected and obstructed vesicles gave rise to a delayed epididymitis.

In addition to the occurrence of epididymitis, there is a small group of scrotal pathological processes incident upon vasectomy which should be mentioned. A few patients have shown minor degrees of wetness of the wound, which we interpreted as probably due to stitch abscesses about the chromic catgut employed for ties. In three cases abscesses in the scrotum in the neighborhood of the severed vas similar to that reported by O'Neil have occurred. In one instance this abscess was accompanied by a great deal of swelling of the scrotum. The abscess contained one-half ounce of pus. In still another case the cords became thickened on both sides down to the vasectomy wound. This we interpreted as vasitis due to an extension of an infectious process down the vas as far as the ligated end. In no way did this infectious process seem to cross the point of ligation. The vas below seemed entirely normal.

In this connection one should mention the statement by Rolnick that occasionally infectious processes breaking down to form abscess have been noted extending along the course of the vas above the point of ligation. We have not noted abscess formation of this nature in any of our cases. One patient in the fourteenth month after prostatectomy which included vasectomy ac-

quired acute gonorrhea. During the most acute stage of the disease abscesses occurred at the point of vasectomy on both sides of the scrotum. These abscesses did not contain gonococci. There was no inflammation of either epididymis.

In addition to these scrotal complications Reed and Morgan have mentioned that in two of their series of eighty-four cases, unexplained scrotal engorgements occurred twelve hours after operation. This subsided in five days. They believed it to be a circulatory phenomenon. Numerous authors both in experimental work and in their prostatectomies have mentioned congestion and engorgement of the seminal vesicles accompanying vasoligation or vasectomy. We have occasionally seen such phenomena but believed them to be rare. Perhaps the explanation is that in patients of the prostatic age the activity of the secreting glands is sufficiently low to prevent this being a normal occurrence. This may explain why vasoligation in man seems to be at variance with the work of Oslund, who stated that in vasectomy in dogs the epididymis is usually distended and hardened by the accumulation of secretions within the epididymis.

In forty-six cases of this series, definite and complete pathological examinations have been made of the excised portion of the vas. It has already been mentioned that in one instance in which vasitis existed on both sides, epididymitis took place following vasectomy. In four of this group of forty-six cases, vasitis was present on both sides without subsequent development of epididymitis following ligation. In one case epididymitis was present on one side at the time ligation of the vas was done. This epididymitis subsided in about the usual length of time. No pus process developed and the patient seems not to have been influenced adversely by the ligation of the vas. We do not feel, however, that our information is sufficiently definite to advocate or oppose ligation of the vas in the presence of epididymitis. We have already mentioned that in one of these patients a normal vas was found at the time of vasectomy but that epididymitis developed subsequent to prostatectomy, which was done considerably later. This infection was probably of hematogenous origin. In one case epididymitis developed where the vas had been missed on both sides. In only two cases of the forty-six examined was any chronic pathology of the vas discovered. In one there was

an atrophic vas with an atrophic testicle on one side. No epididymitis developed. In the other there was a bilateral dilatation of the vas in a patient eighty-two years of age who had had for many years a large benign hypertrophy. No epididymitis developed in this patient. In view of the fact that 77 per cent of the cases of our series showed urethral manipulations previous to vasectomy, 25.6 per cent had been on constant drainage, and 64 per cent of the patients were infected, it seems surprising that the amount of pathology shown by the vas remained so small.

It is interesting to compare what few statistical data there are on the occurrence of epididymitis following vasectomy with epididymitis in the normal course of prostatic surgery and to consider in addition the occurrence of scrotal pathology even though epididymitis does not take place. We have been able to collect 1,624 reported cases without vasectomy or ligation in which there was an occurrence of 21.6 per cent of epididymitis. Including our own series of 141 cases, there are available 514 cases in which vasectomy has been performed. In this group of cases epididymitis occurred eight times for a percentage of 1.5. The new factor, however, introduced by operations upon the scrotum is the group of other scrotal pathology such as abscesses in the wound, abscesses along the cord, and induration of the cord. Including our own group of 141 cases, there is available the work of O'Neil and of Reed and Morgan in which mention of other scrotal pathology is made. These together with our own cases constitute a group of 309 cases in which other scrotal pathology is mentioned. In this group there were eleven cases showing such pathology, a percentage of 3.5. The figures for our own group of cases as regards epididymitis is 141 cases with four instances of epididymitis, a percentage of 2.8. In regard to other scrotal pathology of this group of 141 cases, five cases showed such pathology for a total of 3.5 per cent. We recognize that such figures are altogether too few on which to make sweeping deductions, yet since they are the only figures available, they must serve at the present time as the only basis of comparison by which we may justify the procedure of vasectomy in prostatectomy. We have not been able, either in the postoperative convalescence of our patients or in the behavior of those patients in the months or years fol-

lowing operation, to note any physiological change to differentiate them from similar groups of patients operated for prostate in whom vasectomy has not been done.

CONCLUSION

1. Vasectomy is the operation of choice as a preventative to epididymitis in prostatic surgery. Vasoligation is unreliable. Simple vasectomy with burial of the stump in the scrotal wound seems to be the most satisfactory surgical procedure.

2. Vasectomy, while greatly reducing the incidence of epididymitis, is not certain guarantee against its occurrence.

3. While it is desirable that vasectomy be done on admission of the patient to hospital, early ligation of the vas is not of sufficient importance to jeopardize the welfare of a patient if in poor condition when admitted to the hospital.

4. Although vasectomy eliminates the majority of the cases of epididymitis in prostatic surgery, it adds a small percentage of scrotal complications which are of minor severity in comparison with epididymitis.

5. Vasectomy probably does not exert any physiological effect upon the patient.

BIBLIOGRAPHY

1. ALBARRAN: Medecine Operatoire des Voies Urinaries (Paris), 1909.
2. ALYEA, E. P.: Vasoligation, a preventive of epididymitis before and after prostatectomy. Jour. of Urol., 1928, 19, No. 1, p. 65.
3. ASCHNER, P. W.: Observations on suprapubic prostatectomy. Jour. of Urol., 1924, 12, 251-270.
4. BIER: Quoted by M. Meltzer. Bilateral vasectomy for the prevention of epididymitis in prostatism. New York State Med. Jour., 1928, 28, 1290-1292.
5. BIRKETT and HILTON: Holmes System of Surgery, 1893.
6. COLSTON, J. A. C.: Vasoligation for the prevention of preoperative and postoperative epididymits. Jour. A. M. A., 1928, 90, 526-27.
7. COOPER: Observation on Diseases of the Testes. London, 1845.
8. CRAIG: Discussion of "Bilateral ligation of the vas" by H. W. McKay. South. Med. Jour., 1928, 21, 803.
9. CURLING: Diseases of the Testes. Philadelphia, 1866.
10. GOLDSTEIN, A. E.: Bilateral ligation of the vas deferens in prostatectomy. Jour. of Urol., 1927, 17:25.
11. GOSSELIN: Archives General de Medicine. 1853, *2*; 408.
12. GREGG: Trans. Path. Soc. London. 1905, 56, 80.
13. GUYON: Proc. Congress de Chirurgie, Paris, 1885.
14. MCKAY, H. W.: Bilateral ligation of the vas as a prevention of epididymitis in prostatectomy. South. Med. Jour., 1928, 21; 799-804.
15. MATCH, D. I., and TEAGARDEN, E. J., JR.: Rejuvenation experiments with vasoligation in rats. Jour. of Urol., 1923, 10, 407-414.

16. Moore and Oslund: Amer. Jour. of Physiol., 1924, 67, 422.
17. O'Neil, R. F.: Clinical observations on vasectomy in prostatic surgery. Trans. Amer. Assoc. of G. U. Surg., 1929, 22, 267.
18. Oslund, R. M.: Vasectomy on dogs. Amer. Jour. Physiol., 1924, 3, 70.
19. Pankratjew: Quoted by Werwath.
20. Proust: La Prostatectomie (Paris), 1904.
21. Randall, A.: The role of epididymitis as a complication of prostatectomy. Jour. of Urol., 1926, 16, 141-148.
22. Rathbun, N. P.: Notes on suprapubic prostatectomy based on analysis of 100 consecutive cases. Jour. of Urol., 1923, 10, 415-426.
23. Ravich and McKenna: Amer. Jour. of Surg., 1929, 6, 284.
24. Read, J. S., and Morgan, E. K.: A series of eighty-four cases following bilateral vasectomy for the prevention of postoperative epididymitis. Amer. Jour. of Surg., 1929, 6, 282-284.
25. Rolnick, H. C.: Infections along the sheath of the vas deferens. Jour. of Urol., 1925, 14, 371-383.
26. Rolnick, H. C.: Regeneration of the vas deferens. Arch. of Surg., 1924, 9, 188-203.
27. Scott, W. W.: Blood stream infections in urology. Jour. of Urol., 1929, 21, 527-566.
28. Spangaro: Lo. Sperimentale. 1903, 57, 243.
29. Wallace: Trans. Path. Soc. London. 1905, 56, 80.
30. Werwath, K.: Zur Frage der vaso Ligatur bei Prostatahypertrophie. Ztschr. fur Urol., 1928, 27, 284.

THE CAULK CAUTERY PUNCH OPERATION

A MODIFIED TECHNIC

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That the punch operation has a definite place in prostatic surgery there is no doubt, but from the numerous instruments now on the market, for the performance of this operation, and the enthusiastic reports of its results by some of its advocates, it appears as though the pendulum of approval is swinging a bit too far.

The definite place for the prostatic punch operation is in that type of hypertrophy known as the median bar, and if not complicated by either intracystic, or intra-urethral bilateral hypertrophy, its results are ideal. That it is not the simple "free from danger" operation which some of its advocates claim for it, the case report of a death by Bumpus before this Association three years ago, and the complications and one death which I herewith report, go to prove.

Case 1.—C. S., white, male, aged fifty-four, had typical median bar hyperthrophy. Punch operation was performed, using No. 20 F. retention catheter. Hemorrhage plugged the catheter, causing retention and severe pain, necessitating removal of the catheter, irrigation and removal of large amount of blood and clots, and replacement of the catheter. There was considerable oozing for four days, despite the use of a larger catheter and hemostatic serum. Following the control of the hemorrhage, and removal of the catheter, the patient had constant incontinence for two weeks, and still has it at intervals, four months later.

Case 2.—F. N. F., white, male, aged seventy-eight, had typical median bar hypertrophy. Punch operation was performed using No. 22 F. retention catheter. Slight hemorrhage followed. After removal of the catheter, on attempts at voiding there was a regurgitation pyelonephritis. The patient had rigors, high fever and sweats for several days and was so ill his life was despaired of, but under uritone administered intravenously, pelvic lavage and indwelling catheters, he recovered.

Case 3.—W. W., white, male, aged sixty-two had typical median bar hypertrophy. Punch operation was performed. Severe hemorrhage followed, necessitating suprapubic cystotomy, clamping and ligation of spurting vessel in the vesicle orifice, and a free ooze

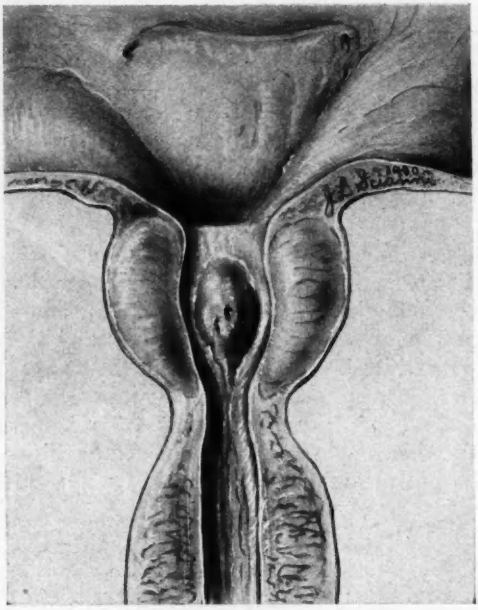

Fig. 1. Median bar with hypertrophied veru.

which required a Pilcher bag to control. The patient left the operating room in good condition with pulse of 110. Two hours later, although no further hemorrhage resulted, he went into profound shock, with systolic blood pressure of 50. Despite every known restorative, including transfusion, we were never able to raise his systolic blood pressure above 80, and he died four days after operation.

In view of the above results, the author feels that a word of caution should be sounded and that the dangers of this operation should be made known in order that every precaution for their prevention should be taken.

With the latter end in view, the author has preceded the cau-

tery punch operation of Caulk, with a thorough application of the Collings electrotome to the median bar, in the hope of diminishing its blood supply and thus lessening the possibility of hemorrhage. Should there be too much bleeding following the punch operation, the Collings electrotome can be applied to the bleeding points through the McCarthy panendoscope. This

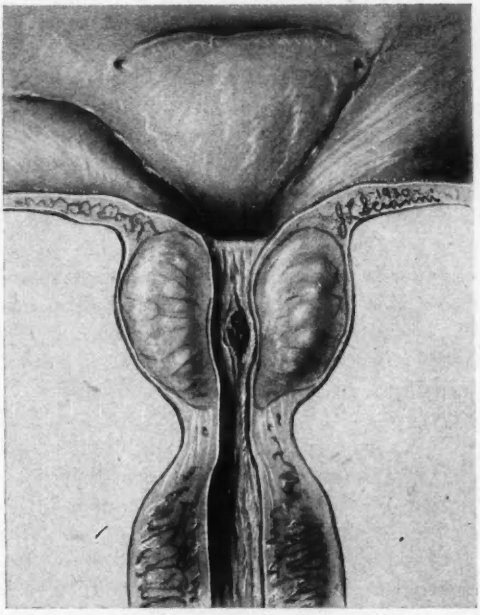

Fig. 2. Median bar with slightly hypertrophied lateral lobes.

last procedure, or rather fulguration, has already been advocated by Young, McCarthy, Braasch, and others. In agreement with Caulk, the author, too, has noted that hemorrhage often results if the indwelling catheter becomes occluded by a blood clot or mucus; consequently he advocates, as does Caulk (Jour. A. M. A., February 8, 1930), the use of a large No. 20 to 24 F. soft rubber catheter, with thorough supervision by a competent nurse.

The prevention of pyelonephritis must also be considered, since this, too, may result following the removal of the indwelling catheter, due to the inability of the patient to void (spasm, congestion, edema, pain) and contraction of the bladder followed by relaxation of the ureteral orifices and reflux up the ureter, ascending infection; or by absorption through the denuded area in the bladder neck and blood stream or hematogenous infection. I believe both may be minimized, if not entirely prevented, by retaining the indwelling catheter for five days. This gives ample time for the progression of healing and subsidence of edema, congestion and swelling, thus diminishing the possibility of absorption, pain and spasm. The intravenous administration of uritone (31 grs.) at the time of operation and just before the catheter is removed is also to be recommended. This should be repeated once or twice a day if the patient has a rigor or fever.

The punch operation is not suitable in that type of median bar obstruction which is accompanied by bilateral intra-urethral hypertrophy. It can be made successful, however, by the application of Collings electrotome to the obstructing bilateral lobes, one or more being necessary to afford relief.

Failure may result, too, where a successful punch operation has been performed and the bar thoroughly removed, if a hypertrophied veru montanum has been left. In this type, in order to obtain a good result, the veru must be destroyed. For this purpose the Collings electrotome has proved most satisfactory in my hands.

Another complication that may arise is difficulty in voiding, or complete retention. This is often due to the pain and soreness in the bladder neck from the punch wounds and is very likely to occur about ten days after operation, due to the exposure of the denuded area when the burned surface, caused by the cautery, sloughs off. This may prove quite annoying and continue several days to a week or more. We have found the replacement of the indwelling catheter, or regular catheterization and the injection of the mild silver salts (argyrol, neosilvol) into the bladder, together with pituitrin by hypodermic injection and tincture of belladonna by mouth, to be of value in restoring micturition.

The Caulk cautery punch operation, as modified, is performed as follows:

The patient is prepared as for prostatectomy. Urotropin is administered, and the bladder decompressed, regardless of the amount of residual urine. One hour before operation the patient is given hyoscine 1/100 gr., and morphin ¼ gr., and if he is not drowsy when brought to the operating room, another ⅛ gr. of morphin is given. Alypin 1 per cent, or butyn 2 per cent, is injected into the urethra and held five minutes. The McCarthy panendoscope is then inserted and the Collings electrotome thoroughly applied to the median bar, and to any intra-urethral lobes that may be present. The veru is destroyed if it is large, the panendoscope is withdrawn, the punch introduced, and the bar removed. We usually remove from two to four pieces. We have found the suction apparatus attached to a cut off catheter, or small tube, passed through the sheath of the punch, a very satisfactory method of freeing the field of urine and blood. Then one or two applications of a cotton swab usually makes the field dry.

After the punch operation is completed the panendoscope is again introduced (especially where there is hemorrhage) and the Collings electrotome again applied. This smooths off rough edges and tags, and controls any tendency to hemorrhage; an indwelling catheter No. 22 to 24 F. is inserted and held in place by adhesive strips. Uritone, 31 gr., is then given intravenously The catheter is removed on the fifth day, urotropin being given in 30 grain doses daily. Should the patient have ascending pyelonephritis following the removal of the catheter, uritone gr. 31 is given intravenously twice daily and if this fails, pelvic lavage and indwelling ureteral catheters usually bring relief. If these fail 10 to 20 c.c. of mercurochrome 1 per cent in glucose 50 per cent has given excellent results.

CONCLUSIONS

1. The Caulk cautery punch operation is applicable only in the median bar type of obstruction.

2. It fails if the median bar is complicated my intracystic or intra-urethral hypertrophy or a hypertrophied veru montanum.

3. It may be made successful in some cases with all of these types by use of the Collings electrotome.

4. Contra-indications: Patients too debilitated to withstand any operative procedure or those whose tests make them dangerous risks.

PROSTATIC SURGERY

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In reviewing medical literature one is struck with the wonderful progress made in prostatic surgery during the last thirty years, but the variable results obtained by the different operators will indicate the need of improved standardized methods in handling cases requiring prostatectomy. Deaver[5] has stated that the average mortality rate from prostatectomy performed by the occasional or inexperienced operator in this field of surgery is between 20 and 30 per cent. Statistics will show this to be true from the very beginning of prostatic surgery, whether by the suprapubic or perineal route. Sir John Thomson-Walker,[16] March, 1930, reported the mortality rate of suprapubic prostatectomy for benign hypertrophy from eleven general hospitals throughout Great Britain from 1920 to 1930 averaged 19.5 per cent in 3,451 operations. The figures of St. Peter's Hospital,[16] London, a special hospital for this class of work, showed a mortality rate of 9.9 per cent in 2,691 cases. This covered a period of twenty-nine years and is a forcible illustration of Deaver's contention.

This high mortality rate to our mind is due to the lack of skill and experience on the part of the operator, the lack of proper preparation of the patient for operation, as well as inefficient after-care. The operation itself is of minor importance after one has become experienced in the operation, but the ability to summarize the findings in a given case and judgment as to the patient's ability to stand the operation, is of vital importance. These require experience as well as good judgment.

Every one recognizes that, in the case requiring prostatectomy, the patient's resisting power is lowered because of age, but, if he is carefully prepared for operation and the findings properly interpreted, the fatalities following the operation should be minimized.

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Great advancement has been made lately in every line of surgery but in no branch, we believe, has greater progress been made than that attained in genito-urinary surgery. The following statistics recorded from 1900 to 1930, we believe, are sufficient to substantiate this statement.

Whitesides[18] reports that previous to 1905 the mortality rate on an average was 20 per cent. The mortality rate in four London hospitals from 1906 to 1910, as reported by Page,[11] was 21.5 per cent. Ramon Guiteras[7] in 1901 reported 152 prostatectomies with a death rate of 16.4 per cent. Benjamin Tenney and Henry M. Chase[15] reported 1,013 cases in 1906 with a mortality of 8.7 per cent.

Pauchet,[12] in reporting 400 cases in 1915, said that the mortality in his first hundred cases was 10 per cent, 8 per cent in the second, 6.5 per cent in the third, and 4 per cent in his fourth hundred cases. He said this progressive improvement was not due to a better choice of cases but to technical modifications of the operation and the better preparation and after-care of the patients. We believe this to be about the reduction of fatalities in the hands of the average urologist.

The combined reports of Proust,[13] Watson,[17] and Escat,[6] in 1904, of 2,396 cases shows a mortality rate of 8.7 per cent. In 1921 John B. Deaver and Leon Herman[5] reported 2,407 cases with an average mortality of 8.9 per cent, but did not give their mortality rate by decades, and quoted the results obtained by the operators listed in Table I.

TABLE I

PERINEAL PROSTATECTOMY			SUPRAPUBIC PROSTATECTOMY		
Operator	Number of Cases	Mortality per cent	Operator	Number of Cases	Mortality per cent
Gile	38	10.3	Gile	24	46.
Dillingham	15	6.6	Freyer	1550	5.33
Watson	110	6.3	Dillingham	85	2.4
Kelley	150	10.	Watson	50	12.
Watkin	100	3.	Kelley	75	20.
Scherck	20	20.	Watkin	60	10.
Gardner	84	19.	Scherck	150	8.
Young	450	3.77	Denslow	200	6.
Leagueu	1026	8.	Gardner	218	4.1
			Walker	112	5.
Average	1993	7.62	Average	2524	6.37

These were skilled operators and their results are considerably above the average.

Fritz Liebig,[10] in a review of the literature, reported 3,234 prostatectomies performed between 1912 and 1916 with a mortality of 9.29 per cent and 2,886 cases operated upon from 1917 to 1922 with a mortality of 6.1 per cent.

In 1923 Hugh H. Young[20] reported 1,049 cases operated upon by himself with an average mortatliy of 3.4 per cent, but did not report his fatalities by decades. He did, however, report his last 198 cases without a fatality. (No such record has been made by any other operator.) Again, in 1928,[19] he reported his last 265 cases with a mortality rate of 3.7 per cent.

Verne C. Hunt,[8] in 1926, reported 1,783 prostatectomies done at The Mayo Clinic with a mortality of 5 per cent but did not give the period of time covered in these operations and fatalities by decades.

Arthur B. Cecil[1] reported in 1928 his mortality of 1.85 per cent in 216 cases of benign hypertrophy. Louis C. Jacobs,[9] in 1928, reported results obtained at Mount Zion Hospital, San Francisco, in 209 cases, with a 5.5 per cent mortality rate.

W. Calhoun Sterling[14] reported in 1928 a mortality rate of 3 per cent in 100 consecutive cases.

R. V. Day[4] reported that Frayer had a mortality of 5.25 per cent in a series of 1,625 cases, most of them performed before accurate methods of determining kidney function and nitrogenous retention were known. He is of the opinion that Chute's estimate of 10 to 11 per cent mortality in hospitals supported by taxpayers is more nearly correct. (The general surgeon as a rule does the surgery in these hospitals.) We admit that the mortality rate of patients operated upon in charity hospitals is high, even when done by urologists, as compared with that done in private practice, but I am sure this estimate is too high in charity hospitals today when the surgery is done by skilled operators.

The records of many operators might be quoted but they all show about the same progress as manifested by their reduction of fatalities. Our own records show a fatality of 6.4 per cent in our report of 170 cases in 1913.[2] Following this we operated in 100 consecutive cases with only one death.[3] From June, 1919,

until May 1, 1930, we performed 415 perineal prostatectomies (68 of these or 16.46 per cent were malignant glands) with an operative mortality of 1.69 per cent. Since March, 1928, to May 1, 1930, we have lost only one patient following prostatectomy in ninety-five cases and this was in a very poor risk at the colored charity hospital. Our fatalities following prostatectomy in charity cases is higher than that obtained in our private cases.

In an analysis of 722 cases of which we have available records, our operative mortality rate is 2.63 per cent. In moving from our old location to our present office, a number of records were destroyed, covering a period of more than four years, and we are unable to give the average fatalities occurring in our practice since we took up urology in 1902. I do know, however, that they were quite high in the first eight or ten years of our work. These were pioneer days in urology and we were deprived of helpful consultants.

The morbidity following prostatectomy has been improved wonderfully during these years and the mortality reduced from at least 20 to near 3 per cent. This accomplishment is the result of the advancement made in scientific instruments, tests necessary to ascertain the amount of kidney damage resulting from the hypertrophied gland and our increased knowledge of the importance of a thorough preparation of the patient for operation. These are of vital importance in prostatic surgery. If the heart and lungs are not diseased and the kidney function good, we feel that prostatectomy is quite safe under local anesthesia, regardless of the patient's age.

Anything which interferes with the elimination of the kidney's secretion inhibits its normal function, and the longer such inhibition persists the greater the damage to the kidney. Pressure atrophy of the kidney is a frequent complication in such cases and may occur even in the absence of residual urine. This is brought about by frequent and labored efforts to empty the bladder. With residual and bladder infection, pyelonephritis and chronic uremia are practically inevitable. In such cases the half-hour 'phthalein elimination test and determination of the non-protein nitrogen of the blood, are of incalculable value in ascertaining operability and time for operation.

Great care should be taken to reduce the residual gradually in cases with a large amount of residual urine and especially in the absence of bladder infection. There is always more or less reaction following drainage in such cases, whether by cystotomy in the two-stage suprapubic operation, by gradual decompression in intermittent catheterization, or by means of the ureteral catheter inaugurating a continuous withdrawal of the residual. In the latter condition—that is, residual without infection—the patient has not built up an immunity against bacterial invasion. In either plan of bladder drainage there is always more or less congestion of the whole genito-urinary tract, and operation should be postponed until this subsides and normal kidney function is restored. The earlier the peak in the 'phthalein elimination and the sharper the curve, the healthier the kidneys.

When drainage is begun by means of the retention catheter, the latter should be connected by rubber tubing to a bottle at the bedside containing an antiseptic solution. It is impossible to prevent infection when the catheter is drained into a urinal between the thighs, even though it contains an antiseptic solution. The catheter should be changed every third day, and the urethra irrigated with some mild antiseptic solution. The bladder is irrigated twice daily with 1:4,000 potassium permanganate or some other antiseptic solution. If infection is present to begin with, it is quite important to get rid of it before operation to prevent epididymitis, infection of the wound and the complications which usually follow.

The postoperative care is equally important. The skill of a surgeon, experienced in urological technic, is necessary in order to detect and treat complications early. The wound should have thorough drainage and the bladder be free of residual. The wound should be dressed as frequently as the dressings are soiled. It should be cleansed twice daily with some mild antiseptic whether the gland has been removed perineally or suprapubically. Just such details as these have made possible the reduction in the mortality rate during this period of time.

In addition we have realized the importance of a careful physical examination to detect and correct remediable defects. High blood pressure is a common occurrence in hypertrophy

of the prostate and when secondary to nitrogenous retention it may be reduced by bladder drainage even before operation.

Local and rectal anesthesia are other factors entering into the reduction of fatalities. The increased skill of the operator has done much to lessen morbidity as well as mortality.

Primary as well as secondary hemorrhage is quite rare today as a result of improved technic and appliances to control it, but it is the cause of an occasional death. Shock, renal and cardiac failure, pneumonia, pyelonephritis, cerebral hemorrhage, embolism, dilatation of the stomach and intestinal paresis are other causes of death. Epididymitis is a frequent complication and retards progress, but it seldom causes death.

It would be interesting to have a full report of fatalities by decades from 1900 to the present time. It would also be interesting to know what percentage of patients die as a result of bladder drainage by cystotomy or by catheter. We have been unable to find any specific report on this problem in a large series of cases, but shall make further effort to do so.

This paper has been prepared with a view to showing the progress made in prostatic surgery and not to compare results obtained by the various operative procedures. Great progress has been made in the surgical removal of the prostate in both of the commonly used methods of approach, and progress is what we are interested in.

REFERENCES

1. CECIL, ARTHUR B.: Immediate and remote results of prostatectomy. Urol. and Cutan. Rev., 32:709-720 (November), 1928.
2. CROWELL, A. J.: The advantages of the perineal over suprapubic prostatectomy. Trans. N. C. Med. Soc., 1913, pp. 104-108.
3. CROWELL, ANDREW J., and THOMPSON, RAYMOND: The results of prostatectomy at the present time. With brief report of 100 consecutive cases with one death. Urol. and Cutan. Rev., xxiii, No. 8, 1919.
4. DAY, R. V.: Symposium on urology: Problems in prostatectomies. Southwest. Med., 9:307-311 (August), 1925.
5. DEAVER, JOHN B., and HERMAN, LEON: The prognosis in prostatectomy. Arch. of Surg., 2:231-245, 1921.
6. ESCAT: Annals des Malad. des Org. Genitourin., 1904, p. 1635.
7. GUITERAS, RAMON: Prostatectomy versus prostatotomy in the radical treatment of senile hypertrophy of the prostate. Jour. A. M. A., 37:1156-1161 (Nov. 2), 1901.
8. HUNT, VERNE C.: Benign prostatic hypertrophy. Surg., Gynec. and Obstet., 46:769-773 (June), 1928.
9. JACOBS, LOUIS CLIVE: The surgical prostate. Calif. and West. Med.,

10. LIEBIG, FRITZ: Die Prostatahypertrophie. Ztsch. f. Urol., 17:593-613; 625-659, 1923.
11. PAGE: Quoted by Deaver and Herman.
12. PAUCHET, V.: Prognosis of prostatectomy based on 400 cases. Urol. and Cutan. Rev., 19:373, 1915.
13. PROUST: Annals des Malad. des Org. Genitourin., 1904, p. 1697.
14. STIRLING, W. CALHOUN: Review of 100 cases of prostatectomy with especial reference to early diagnosis. Va. Med. Month., 55:699-704 (June), 1929.
15. TENNEY, BENJAMIN, and CHASE, HENRY MELVILLE: Mortality after prostatectomy. Jour. A. M. A., 46:1429-1430 (May 12), 1906.
16. THOMSON-WALKER, SIR JOHN: Enlarged prostate and prostatectomy. Third Lettsomian Lecture. Brit. Med. Jour., p. 511 (Mar. 15), 1930.
17. WATSON: Ann. of Surg., June, 1904.
18. WHITESIDES: Quoted by A. J. Scholl and A. A. Kutzmann. Calif. and West. Med., 30:195-196 (March), 1929.
19. YOUNG, HUGH H.: Epidural caudal anesthesia in prostatic hypertrophy. Jour. A. M. A., 90:1021-1023 (March 31), 1928.
20. YOUNG, HUGH H.: Prostatectomy—Preoperative, operative and postoperative treatment. Surg., Gynec. and Obstet., 36:589-612, 1923.

DISCUSSION

DR. ALEXANDER RANDALL (Philadelphia): Mr. Gladstone, premier of England, was once heckled by his audience for having made statements that were the opposite of what he had previously held. His reply was that he would speak the truth as God gave him to understand the truth, no matter if he controverted everything which he had but yesterday said. I rather fear that I have been responsible for perpetrating a pathological error.

Dr. Livermore started off with a statement concerning performing a punch operation in a "type of hypertrophy known as median bar." I do not know that it would be fair to ask him what he meant by that, but I do think it is time that, speaking from our knowledge of the basic facts of pathology, we learned to purify our terminology.

Some years ago in studying median bar conditions I am afraid I was guilty of grouping them as "fibrous" bars and as "glandular" bars. Since that time I have purposely striven to correct that classification because of its ambiguity.

Median bar was given us close to 100 years ago by Guthrie, a pathological entity that was twice lost and three times rediscovered, and I think we ought to start today, if necessary, in understanding one another when we speak of a median bar.

Pathologically, my firm conviction is that it is an inflammatory process causing a fibrosis or sclerosis of the vesical orifice. We can argue, if we wish, in regard to its etiology, but that essentially is a bar as I think we ought to understand it.

Now, we do have obstructive conditions at the vesical orifice, especially at the posterior portion of the vesical orifice, giving clinical evidences of prostatism, giving cystoscopic pictures of bar formation that are, on the other hand, essentially hypertrophies, and that is, I am sure, of what Dr. Livermore was speaking. That is the type of pathological change which I tried to call glandular bars, but it has led to confusion. Those conditions in which hypertrophy is present at this posterior portion of the vesical lip are localized hypertrophies in the posterior prostatic commissure.

Two other things I think are important in this symposium:

First, Collings has consistently refrained from advocating his operation in conditions of prostatic hypertrophy, and I think he is right; second, Dr. Cunningham's paper was not presented in this symposium, and I think it would have opened up the most interesting part of this group of papers, because it also is my firm conviction that these cases of recurrent prostatic hypertrophy or recurrent conditions of prostatism, are time and again due to partial prostatectomies.

Looked at from the point of view of the patient, who presents himself postoperatively, with symptoms of recurrent prostatism, there are five conditions which could cause such a situation. The first occurs in the case of the surgeon who operates in the hope of removing a prostatic obstruction where the major part of the picture is caused by a neurogenic lesion. The second is the performance of a prostatectomy and overlooking, let us say, a large diverticulum. The third is the performance a prostatectomy and allowing the patient, either from surgery or from postoperative care, to develop a cicatrization of the vesical orifice. The fourth is the performance of a partial prostatectomy at the time of operation, and leaving behind hypertrophic tissue. That is the kind that I think really belongs also in the group where punch operations are done on hypertrophy, because I cannot conceive, from a pathological viewpoint, how any man with a punch instrument can remove all of a prostatic hypertrophy.

The fifth condition is one that I think we shall learn to appreciate later; that is, that when a prostate starts to hypertrophy, it does not burst into bloom in all its portions at one time; it is comparatively easy to establish the fact that a prostate will start hypertrophying in one localized area with other areas developing at later periods. It is perfectly conceivable that a surgeon can remove today localized hypertrophic glandular tissue, only to have the same prostate five years, ten years later, develop hypertrophy in another, until then, uninvolved portion of its glandular tissue. Those are the cases of true recurrent prostatic hypertrophy, and of course they give symptoms of prostatism.

Dr. John R. Caulk (St. Louis): I am glad to see Dr. Livermore interested in the punch. One can see he is extremely interested because he has practically rigged up a Goldberg apparatus to take care of all the processes, but that really has a compli-

mentary aspect; I mean it sincerely. He has shown how we have to use every delicate measure in the world to take care of these cases before and afterward. There is no question about that.

I am not going into all the phases that Dr. Randall brought up. I disagree with him entirely in the latter part of his statements. I feel that in the removal of tissue by one measure or another from the orifice of the bladder, we must keep an equipoise or perfect balance between the amount of tissue removed and the insult and offense that we create to surrounding structures. I mean if we overburn in proportion to the amount of tissue removed, we are then creating the very thing that we want to shun, that is slough, chance for secondary hemorrhage, chance for secondary infection, and chance for late contracture. They are the things we want to avoid, and I feel that we can keep this balance and minimize bleeding and then take care of bleeding which is bound to come in many instances if we remove many pieces of tissue, by other measures, particularly by catheter drainage properly performed.

I feel that the large indwelling catheter, watched carefully, is the one efficient measure of handling the bleeding after these punch operations. I put in a No. 28 to a No. 32 French catheter, soft rubber, cut large eyes in the catheter myself, and place one eye, the large one, on the floor of the bladder, and regulate it. These patients go back and are watched very carefully, so that they are not impeded one bit. If one little clot gets in, we have a syringe and sterile water and salt solution right at the bedside, and it is aspirated immediately. Spasm, hemorrhage, contraction, inefficient drainage are the things that create most of the bleeding. I have never seen one go on without obstruction to the catheter outflow. If we take care of the patient properly and the house man watches him properly, hemorrhage does not bother.

I have lost two patients; one was a bleeder and one's catheter came out, a carcinomatous case, during the night, and he went six hours with a bladder full of clot, and we couldn't restore him. That makes three-tenths of 1 per cent mortality in nearly 600 cases.

I want to pass these pictures around to show you one thing.

Personally my best results are in the larger cases. I am sure they are hyperplasias of inflammatory origin.

Here is the trouble with you men, all of you. Your ideas are through impressions, not by practical application. I am positive of it. Or you have taken the punch on these larger cases, and you have followed history and have taken out just one or two pieces, your man is no better and you say your punch operation is no good. I have done four operations and taken as high as sixteen and eighteen pieces out, and the patient was no better than when I started. Then I have operated again and taken one simple little piece out and the patient was perfectly cured. I watched him for years, five, six, seven years. Some of them I have watched ten years, and these prostates have gone down and have stayed down.

We follow these operations by local treatment, as one does chronic inflammatory conditions of the prostate and vesicles.

The only other point I want to mention is that we are likely to overestimate the character of the obstruction in a prostate by cystoscopic study, and this picture (indicating) is designed to show you that. There is a lobule there that looked like the large intravesical obstructions that we see cystoscopically. I removed this little piece. The picture changes from one time to another. We go back and get it somewhere else. I removed this little piece as we commonly see it pictured; the artist looks at it with a cystoscope, just as we see it in the bladder, and shows this picture here (indicating), which is the same thing, and one feels he has not accomplished much, but he has taken out a lot more proportionately to the cystoscopic picture than may be realized.

We do not take out all the obstruction. We take more than we think in proportion to our cystoscopic picture, and certainly a tremendous lot of absorption occurs. I am positive if you men would be patient and on some of these bad risks that you don't want to subject to these larger operations try these things repeatedly at intervals of two, three and four weeks, I am sure that you will agree with me when I say that I am not exaggerating or lying to you concerning the things I have told you.

Dr. Arthur L. Chute (Boston): I am sure I have enjoyed this discussion very much, but I have very little to say about

it. I agree with everybody except Dr. Caulk, and I am sure if I had had his experience I should have agreed with him.

There is one thing I want to touch on, and that is Dr. Crabtree's paper and its clinical aspects. I have done quite a number of vasectomies, and I don't always get the vas, I am willing to say. Two or three times I have gotten a little vessel instead of the vas. I didn't find it out until afterward.

I cannot see how our statistics are going to count much until we get a sort of crystallized operative technic and are sure that we cut the vasa. It has only been recently, within two or three months, that I had one man on whom I thought I had done a beautiful operation. I cut both vasa. He had very little, if any, catheterization. I tied his vasa, and before I did anything he developed one epididymitis while in the hospital, and another on the other side shortly after going home.

I did not know what to think about it. It cuts down my incidence of epididymitis a great deal. In my hands this operation does not work perfectly.

There is one thing I would suggest. I have done one or two vasectomies where there has been an epididymitis beginning, and then I have always left the lower end of the vasa in the wound just attached to one side. I do not know that it does any good.

I have enjoyed Dr. Crowell's paper very much. It sounds like old times. It is very interesting.

Dr. Richard F. O'Neil (Boston): I should like to say a word in regard to the paper on vasotomy. Last year I reported before this society eighty-four consecutive cases. There was only one case of epididymitis, and that was a hematogenous infection following a streptococcus infection of the throat.

Dr. Crabtree spoke of the occurrence of local inflammations and abscesses. In a number of cases I have found quite a little induration about the cut ends of the vas following the vasotomy. The operations are done routinely by the house officers, and as far as I know we haven't missed the vas yet. I suppose we may.

Dr. Caulk: May I ask how you do your vas operation?

Dr. O'Neil: By open dissection. We pick up the cord, deliver it, isolate the vas, and divide it between two ligatures.

Dr. Thomas: Where is the incision made?

DR. O'NEIL: In the upper part of the scrotum.

DR. THOMAS: In the scrotum, not in the groin?

DR. O'NEIL: In the upper part of the scrotum.

DR. HERMON C. BUMPUS (Rochester, Minn.): I want to confirm what Dr. Caulk said. I haven't done 600 operations, but I have done over 300, and I think that failures in the punch operation in the past have been for two reasons: First, the attempt to punch out cases where you have very large bilateral lobes and, second, the failure to remove sufficient tissue. If the hypertrophy is confined to the median lobe and is glandular, one certainly obtains the best of results. I have many of these patients now that have gone over five years, and we have not had them come back with recurrence. Possibly they are going to later on, but residual urines up to 16 ounces are completely relieved and stay relieved for years.

I used to use catheters. That was before I took out as much tissue as at present. I have not been adopting the method of doing the work repeatedly, but try to do it all at one time. In the last case in which I performed this operation, last week, before coming away, 5.5 grams of tissue from a median lobe were removed. Complete hemostasis is obtained before the patient leaves the table, so that the irrigating fluid comes back absolutely clear and there is no bleeding.

If the obstruction is all removed and the hemostasis is complete, then there is no occurrence of the spasm to which Dr. Caulk refers. There are no clots forming, or the constant tenesmus to try to expel them, which keeps up the bleeding; and the use of a catheter being unnecessary there is no irritation and no inflammatory reactions that occur when a catheter is used. If the amount of tissue removed is sufficient so that the obstruction is removed, the patient voids perfectly freely as soon as the bladder fills, and the usual convalescence is from three to four days.

The death that I reported last year was not due to a hemorrhage. It was a death that came apparently from a prostatic abscess of secondary infection. That is the only death we have had in over 300 cases of punch operation, and some of these patients have gone on now for over five years with complete relief of symptoms. I think this operation certainly has a place.

I want to emphasize the point that if all of the obstructing tissue is not removed, there is bound to be some edema immediately, tenesmus and bleeding, with the necessity of inserting a catheter. Dr. Collings' knife is splendid for cutting the bar, but for removing any appreciable amount of tissue I have found it disappointing. I often use it in conjunction with a punch operation. In removing the median obstruction, one is working with a circular knife; there is a circular outline to the area excised. If a still deeper trough is desired, the Collings' knife may be used to cut a trough from the trigone down to the cerumontanum and thus insure an absolutely complete drainage. The important thing is to have the whole urethra free of any form of obstruction if the convalescence is going to be good.

DR. GEORGE R. LIVERMORE (Memphis): I would like to ask Dr. Randall one question. Have you used the Collings electrotome on any of these hypertrophied bilateral prostates?

DR. RANDALL: I have not.

DR. LIVERMORE: Then you haven't any right to talk against it. I don't care about the nomenclature, and if I have offended you in calling it a median bar I am very sorry. That is what Young calls it in his urology. We can call it a hypertrophy of the commissure or any type of obstruction that you wish, but it is the obstruction due to an enlargement of the lower portion of the neck of the bladder or the projection upward of the floor of the internal meatus which causes a distinct obstruction and prevents the free flow of urine from the bladder. If you can take that piece out, punch it out, burn it out, whatever you do to it, as Bumpus said, just so you remove it, you relieve that obstruction and you get results.

Why did I take up the punch from Caulk? I had a patient that came from fifty miles below Memphis. We did a suprapubic operation and prepared him for prostatectomy. I thought it was absolutely impossible to relieve that fellow by any other type of operation but a complete removal of the prostate. There was bilateral intra-urethral and bilateral intracystic hypertrophy with those bulging lobes that one sees from above, bulging down into the bladder. Somebody told him about John Caulk, and that he could do it without cutting him, so he went to St. Louis. John operated on him, and I laughed at it, because the man

came home and was home only a few days when he had complete retention and had to go all the way back to St. Louis. I said I knew he couldn't be relieved by a punch operation. What did John do? He took him back to the hospital and punched him again. He was all right for a while, but had another setback and I said, "Ha-ha, of course, it can't be done." He went back to John and he operated on him a third time and sent him home, and he has been absolutely relieved. I watched the fellow for over two years, and he is still relieved.

I had a man with the same type of bilateral hypertrophy, only a larger one, with 14 ounces of residual urine. He wouldn't let me operate on him. I didn't think that John Caulk's punch would do any good, so I used Collings electrotome, and had to apply it six times. He now has 1.5 ounces of residual urine. He tells me he gets up only once at night and as far as the bladder function is concerned he is absolutely relieved. That man has gone two years and a half, and he hasn't had any more trouble.

If he has trouble again, wouldn't you use a Collings electrotome? Wouldn't you rather have one applied to you several times than to undergo a complete prostatectomy? That is John's argument, and he is right, and anybody who will try it will come to the same conclusion.

DR. ALEXANDER RANDALL: I will attempt to answer Dr. Livermore's question. I have not used the Collings operation on true lateral lobe hypertrophies. The old dictum that if you want to get a master's result you have to follow a master's technic is always worth following, and Dr. Collings himself has repeatedly stated that he does not advise the use of his instrument in prostatic hypertrophy.

This old song of "Punch brothers, punch with care" is again rising from the banks of the Mississippi, and the results that they get are perfectly right and true, but who, with any experience in prostatic obstruction, hasn't likewise experienced exactly the same amount of temporary relief by putting in a soft rubber catheter? It is nothing at all but the question of relieving a transient prostatic congestion, getting the patient to emptying his bladder, free of symptoms, and traveling for indefinite periods of time on this false assumption that he is cured. Of course,

when the patient has a recurrence of acute retention one must punch again, but that I do not call surgery. I would not accept it for myself, and I would not advise a patient to have it. It is all right to speak of how simple the punch operation is, and yet today we have heard of mortalities from infections and mortalities from hemorrhages. It is not as simple as we are led to believe, and it is ineffectual in curing permanently when true hypertrophy is present.

DEEP URETHRORECTAL FISTULA FOLLOWING SUPRAPUBIC PROSTATECTOMY—CURED BY THREE-STAGE OPERATION

ROGER C. GRAVES, M.D.

Boston, Massachusetts

The unusual character of the injury and the difficulties involved in its repair have led me to report this case. Rectal wounds complicating perineal prostatectomy are by no means uncommon, especially in the hands of those who have not been long familiar with the surgery of the perineum. These wounds are usually low, relatively near the anus, and they are caused, probably in most instances, at the time of the division of the central tendon and the recto-urethralis muscle, though the tear may be made in cutting across the posterior layer of Denonvillier's fascia. Suprapubic perforation of the rectum during the enucleation of a benign prostate occurs much less frequently in spite of the readiness with which the operation is undertaken, often by operators who have no particular experience in this field of surgery. That it may occur should be borne in mind, especially in those instances in which the gland is fibrous and very adherent. The case which follows is the first that I have known of, personally. Young, in his recent textbook, lists two suprapubic injuries in his group of seventeen urethrorectal fistulæ, requiring radical surgical repair.

The patient, an American railroad worker, aged fifty, was brought to me from another city by his doctor, June 29, 1929. He was in a state of somewhat depleted general health, as his illness had lasted for many months. There was a permanent suprapubic catheter in the bladder, through and around which drained small amounts of fecal-stained urine and mucus. Most of his urine was voided per rectum. He had passed nothing through the urethra for the past four months. He had no pain. The temperature, pulse, and respirations were normal.

The doctor informed me that he had first examined the patient in August, 1928, and that at that time there was a story of urinary distress in varying degree, for the preceding fifteen years. Venereal

disease was denied. On cystoscopy he found the bladder infected, sacculated and markedly intolerant. There were several small stones, one of which was removed from a depression in the prostatic urethra. The urine was filled with pus. The prostate presented an intra-urethral hypertrophy and residual urine varied in amount from time to time, between 6 and 12 ounces. He advised prostatectomy but a long period of bladder irrigations was undertaken first in an effort to reduce the infection. During this time the patient continued to have occasional very painful attacks in which he passed gravel. The doctor stated further that "other symptoms of enlarged prostate were practically always present. Operation was performed February 27, 1929, and the prostate removed by Squier's intra-urethral enucleation. The prostate was markedly adherent to the posterior capsule, so I imagine that the fistula occurred in the attempt to break up these adhesions. A large Freyer tube was sutured *in situ*. On March third (fourth postoperative day) a fecal odor was noticed in the drainage."

When I first saw the patient, about four months later, his routine physical examination was essentially negative except for the midline suprapubic scar in the lower pole of which was a sinus containing a small soft-rubber catheter. He was mentally active and very cooperative. The blood pressure was 125/75. The red blood count was 4,800,000; hemoglobin, 85 per cent; smear and differential count normal. The leukocyte count was 6,600. The blood Wassermann was negative, and the blood urea nitrogen 17.5 mg. per 100 c.c. The admission specimen of urine was cloudy, alkaline, 1.008; albumin, trace; sugar, negative; sediment, very numerous triple phosphate crystals, a few leukocytes; no blood and no casts.

On abdominal palpation, there was no renal tenderness, and the kidneys could not be felt. The external genitals were normal. Rectally, there was a small puckered area with marked induration around it, high in the midline of the anterior wall of the rectum, almost at the level of the internal bladder sphincter.

Cystoscopy.—Under novocain, a No. 24 McCarthy cysto-urethroscope was easily passed along the urethra to the bladder, but there was a distinct jump at the level of the bladder neck. A large amount of brown fluid, fecal in appearance, escaped through the instrument. The bladder was normal in tone and capacity, and showed but little inflammatory change except around its outlet and over the trigone, which was raised and thickened. Above the region of the right ureter were two shallow cellules, one of which held a small concretion. The orifice of the right ureter was not seen; the orifice on the left was normal in appearance. Around the sphincter margin there was encroachment upon the bladder outlet, in all quadrants, with a marked anterior commissure. Both lateral lobe regions bulged distinctly and there was a rounded fullness in the

region of the middle lobe of the prostate. On the floor of the deep urethra, at a point which seemed about midway between the two sphincters, there was a transverse opening surrounded by adherent gray slough. A No. 5 ureteral catheter was easily threaded into this opening and then could be felt emerging from the puckered area in the roof of the rectum. Palpation against the cystoscope in this region also found what suggested prostatic tissue, especially on the right side.

After careful consideration, these conditions did not seem to me to lend themselves favorably to the ingenious rectal-cuff operation which Young has employed so successfully for the cure of these cases and which he first described before this society in 1913. I felt that the fistula was too high to permit of so much mobilization of the rectum, and, after doing the perineal portion of the repair, I was convinced that this was so. A three-stage operation was decided upon.

After a few days of general medical preparation and antiseptic lavage of the bladder, the first operation was performed July 9, 1929. Spinocain anesthesia was used. The abdomen was prepared with iodin and alcohol after withdrawing the suprapubic catheter. Through a small left rectus incision a loop of sigmoid was delivered and secured to the abdominal wall in preparation for a colostomy. This field was then carefully isolated and a midline suprapubic incision was made approaching the bladder in the usual manner, but extending much higher than the original scar. This scar and the sinus were completely excised. The opening in the bladder, which was low beneath the symphysis, was enlarged upwards to the apex of the organ. There were no intravesical changes except redness and generalized edema. The region of the bladder outlet lay at the bottom of a narrow funnel-shaped formation, which made it difficult to visualize. The urethral orifice was on the left of the midline, and it was very small and rigid, as though contracted by scar. It was carefully dilated with the finger, but no prostatic or scar tissue was found which could be excised with any advantage. The cystoscopic appearance of obstruction had been caused, apparently, by edematous mucous membrane. It was hoped that this edema would subside when fecal infection had been overcome. A soft-rubber catheter could be passed easily through the now dilated sphincter and out through the penis. The bladder was then closed with two rows of sutures of plain catgut around a large Pezzar catheter emerging from its highest point. The remainder of the wound was painted with 2 per cent mercurochrome and closed with interrupted figure-of-eight sutures of silkworm gut. A cigarette drain was left in the prevesical space. The patient left the operating room in good condition and his immediate convalescence was satisfactory. The colostomy was opened on the third day; it functioned

well and continued to do so throughout the time that it was used.

On the eleventh postoperative day and for the week following, the patient had the symptoms of an acute pyelonephritis, with chills and high fever. Apart from this he recovered rapidly and was out of bed on the twentieth day. The bladder was irrigated with potassium permanganate solution at frequent intervals. The suprapubic drainage was excellent, and urine was no longer voided per rectum except occasionally when the catheter became temporarily occluded.

The second, or perineal, operation for the repair of the fistula was performed August 13. The anesthesia was spinocain. The field was prepared with the alcohol-acetone solution of mercurochrome: 1:500 aqueous mercurochrome had been used the day before to wash the rectum from below upwards through the colostomy opening. Just before operation, the urethra was irrigated with the same solution. The patient was placed in the extreme lithotomy position and a perineal flap turned down, permitting the separation of the rectum and urethra in the usual manner. A sound and, later, a long prostatic tractor were kept in the urethra through much of the dissection. Adherent levator fibers were divided on each side to allow an exposure of the rectum as far as the prostatic capsule and region of the fistula. The fistula itself was developed with the greatest difficulty because of its high position and the extensive scar tissue around it and the danger of further tears in the bowel and urethra. The two structures were separated finally in a fairly satisfactory manner and the rectal opening was closed in two layers. Interrupted sutures of No. 00 chromic catgut were used, followed by a second layer of No. 1 chromic infolding sutures which buried the first row of stitches. Two per cent mercurochrome solution was used freely in the wound to sterilize the suture lines as much as possible.

The hole in the urethra easily admitted the index finger. It was in the prostatic capsule just outside the outlet of the bladder, and there was very little sound tissue available for its closure. Moreover, the condition of the patient made it necessary to hurry with this stage of the repair. Two sutures of No. 00 chromic catgut brought together the edges of the opening. Levator muscle fibers were then approximated between rectum and urethra in this region and the drain to the base of the wound was placed above this bridge of muscle to avoid pressure against the bowel. The central tendon of the perineum was restored with a single mattress suture, and the skin flap was closed with silkworm gut. The cigarette drain to the bottom of the wound emerged from one angle of the skin incision, while a small wick drained the superficial tissues in the other. The operation was long and the patient left the operating room in a state of moderate shock. He recovered from this very promptly,

however, with caffein-sodium-benzoate administered intramuscularly and a transfusion of 600 c.c. of citrated blood.

The rest of the convalescence was highly satisfactory. There was never the slightest sign of fecal leakage from the perineal wound, though urine escaped for a time if the suprapubic tube became blocked. The wound was kept clean by daily irrigations with S. T. 37 through a small catheter gently passed along the drainage tracts in the two angles of the incision. Warm oil was occasionally introduced into the rectum to prevent the impaction of dry fecal material in the lower bowel. The final healing was complete and firm, and the patient was out of bed, entirely dry, on September 19.

On September 30 sounds were passed and an indwelling catheter was placed in the urethra. As it drained well, the suprapubic tube was removed the following day. The intervals between these principal events now appear long, but it seemed wise to allow the region of repair to become as firm as possible before subjecting it to the slightest strain. The suprapubic sinus closed completely within a few days and after one week of urethral drainage the catheter was taken out. From then on, the patient voided normally.

October 29, after careful preoperative preparation with oil enemata and oil by mouth, the colostomy was closed under gas-oxygen-ether anesthesia. The bowel was drawn back into the abdomen through a fresh incision medial to the original left rectus scar. The colostomy opening was repaired with infolding sutures of catgut in two layers and a third layer of linen, which brought pads of fat into apposition with the suture line. The wound healed quickly; there was no fecal leakage, and the patient was out of bed, with bowels moving normally, on the twenty-first postoperative day.

Nine days later, on November 28, he left the hospital in excellent condition. A No. 22 sound was passed the day before discharge. All wounds were firmly healed and there was normal control of bowels and bladder. The blood pressure was 138/70. The final specimen of urine was pale, 1.008, neutral; albumin, negative; sugar, negative; sediment, an occasional leukocyte.

It had been a long struggle, but the condition of the patient when we began was so deplorable that he was eager for salvage, no matter what the expenditure of time might be. I have seen him from time to time during the past several months. He is back at work and enjoys vigorous health. When he first returned to full physical activity there was a very slight dribbling of urine, occasionally toward the end of the day, but this had not occurred for three weeks when I last saw him. My only

personal dissatisfaction in the case lies in the difficulty of passing instruments through the urethra. This seems to be due to a distortion from scar and inflammatory change in and around the prostate, rather than to any serious narrowing of the urethral lumen. Certainly it is more troublesome to me than to the patient, for he states that he voids freely and better than he has for many years.

ABSCESS IN THE WALL OF THE URINARY BLADDER

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Mr. W. P. L., thirty-nine years old, is married, and has two children. He is a short, muscular man, 5 feet 8 inches in height, and usually weighs 175 pounds. His occupation as an officer in a manufacturing concern is confining, and allows him to take exercise irregularly.

His previous history is of but little significance. He had some of the diseases of childhood, no serious illness in adult life, no injuries, and denies venereal contamination.

In the last week of July, 1929, while at the tee on the third hole in a golf game, he swung violently at the ball, missed it, and felt something give way, or snap, in his lower abdomen. The pain was not excruciating, but sharp, of short duration, and indefinitely located around the navel. He sat down on a bench for a few minutes, "held his stomach," resumed playing through the thirteenth hole, quit, and went home. For several days following this incident, he was uncomfortable in the lower abdomen, but continued with his work. The third of August he went to bed for a few days. About the middle of August he drove his machine to Niagara Falls and from there to Pittsburgh, but came on shortly to Richmond. It was about this time that he began to notice that he had considerable pain on urinating. The pain was terminal, and two or three times he had seen some blood in the urine. Although he continued at his work, he still felt badly. The dysuria was getting slightly worse each day, and on one or two occasions he had a chill, and more or less constant headache. October 8 he went to New York, but was not well. October 15 he felt so sick that he called in Dr. Alexander G. Brown, who recommended that he go to a hospital for a more thorough investigation. On October 16 he entered Stuart Circle Hospital, Richmond, Virginia.

There was a rigidity of the lower abdominal muscles, particularly on the right, and on deep pressure at McBurney's point the patient complained of pain, although there was no nausea or vomiting, and the bowels were moving daily. A day or so later the pain was more mesial and retropubic, and on deep pressure some resistance was elicited. Temperature was 101.2; pulse, 90. The serological findings were as follows: hemoglobin, 58 per cent (Newcomer); white blood cells, 15,400; neutrophiles, 84 per cent; lymphocytes, 9 per cent; coagulation time, 3.5 minutes. Wassermann and Kahn

tests were negative. Urine was acid, with a faint trace of albumin. Blood showed 2 plus (basis, 4 plus); pus cells, 1 to 2 (basis 4), few large, and small epithelial cells. Direct smear was negative.

October 20, rectal examination revealed the sphincter tight, irritable, the mucosa soft and edematous; prostate tender, irregularly enlarged, notch defined. What was taken to be the posterior margin of the right vesicle was indurated and painful. There was

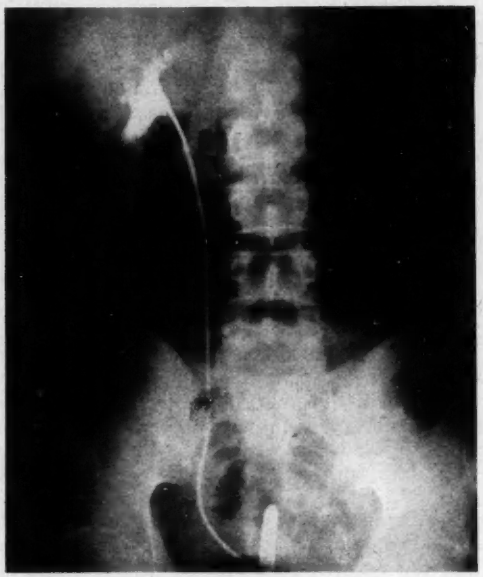

Fig. 1. Pyelogram negative.

no expression on attempted massage. The cystoscopic investigation was done by Dr. J. G. Geisinger, October 21, who reported as follows: The patient was examined for exclusion of invisible ureteral calculus as cause of symptoms. No obstruction was met in the right ureter and waxed bougie was negative for scratches. Pyelography was also negative, although there was some irregularity of the lower calix, due, probably, to insufficient filling. This apparently excluded calculus. On the posterior vesical wall, however, somewhat above the midpoint, between the air bubble and base of the trigone, was a peculiar large edematous, congested, puckered area, with heavy radiating rugæ, and a central, somewhat depressed, area, which was not indurated. Appearance of the involved zone sug-

gested induration or inflammation, rather than malignancy. It could represent a coincidental condition, or it could be an intravesical expression of an essential lesion external to the bladder wall, perhaps in the abdominal cavity. Culture of catheterized specimens from the bladder and right kidney showed staphylococcus.

Fig. 2 Longitudinal section showing communication between the lumen of the urachus and the bladder.

X-ray film by Dr. F. M. Hodges, October 18, showed the kidneys normal in size and position; no stone seen; spine, negative.

October 21, X-ray of the genito-urinary tract showed catheter in the right ureter. Kidneys were normal in size and position; no stone seen; lumbar spine, negative. Pyelogram of the right side showed the lower calix not entirely filled, otherwise appeared to be negative. Cystogram indicated the superior surface of the bladder to be very irregular. This could be due to a growth or to abnormally heavy rugæ, but the remainder of the bladder was smooth, and this was against a local hypertrophy of the rugæ.

That the condition was surgical was evident, and the provisional diagnosis of Meckel's diverticulitis was made, this being the nearest pathological state to a "male pus tube" deep in the pelvis and adhered to the posterior bladder wall that could be thought of.

October 22, under ethylene gas, a right rectus incision was made. The peritoneal cavity was readily gained. There was no fluid, flakes, adhesions or pathology. Caput was sought; appendix was normal and was not removed. The incision was extended downwards, and the hand, when thrust into the pelvis, felt anteriorly a tumor the

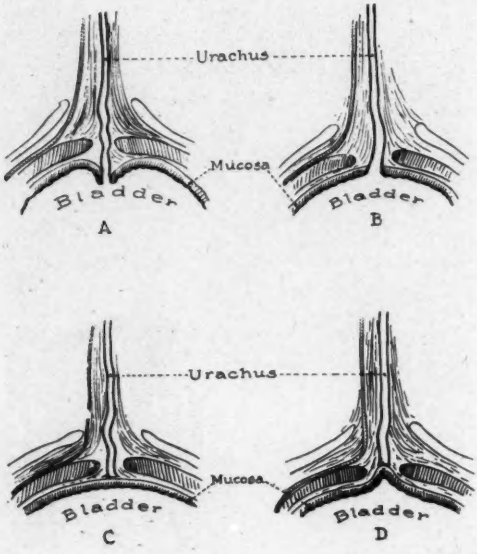

Fig. 3. Various types of communication of urachus with bladder wall and cavity (after Begg).

size of a child's fist, extraperitoneal, and apparently incorporating the upper posterior wall and the vault of the bladder. The consistency was very dense, firm and hard, and did not pit on pressure. It was fixed, and shaded off laterally to the bony pelvic wall. Inferiorly the structures were normal, there were no adhesions, and there was nothing in the pelvis. Our first impression was that we were dealing with a tumor involving the posterior wall of the bladder, and probably sarcoma, we having reported such a case about a year ago, before the American Association of Genito-Urinary Surgeons. It was decided to explore this condition suprapubically and extraperitoneally, so the right rectus wound was immediately closed with no drainage.

The bladder had not been filled, and it was approached with caution. Its anterior wall just above the pubes was normal, but for

engorged veins and a moderate edema, and the investigating finger could now feel more superiorly the dense induration for which we were searching. The incision was extended upwards towards the navel, and the hard, white tissue, extraperitoneal, involving and infiltrating the bladder wall, came into view. A slice was taken from this tumor-mass for frozen section, and reported back immediately

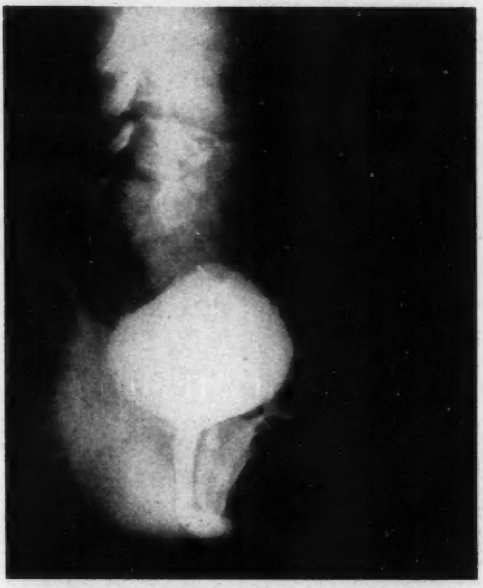

Fig. 4. Cystogram—Lateral view. Definite filling defect on superior posterior wall.

by Dr. Beck, "muscle tissue showing acute inflammatory reaction throughout." A pair of sharp pointed hemostats were thrust with some force downwards and backwards through the biopsy incision into this rind-like substance, for an inch or more, and about 2 ounces of heavy, creamy pus was evacuated. The finger put into this cavity (about the size of a small hen's egg) could feel its cavernated, rough walls, there being greater resistance posteriorly than anteriorly, the separating membrane from the bladder feeling thin and slick. A soft-rubber tube was inserted into this pocket, and since there had been a generous escape of pus over the operative field, another tube was put in the space of Retzius. The recovery was uneventful. There was never an escape of urine through the

tube. The pussy discharge became less daily, and the patient was dismissed November 12, 1929, in a very satisfactory state.

It is evident that we had been dealing with an abscess in the musculature of the posterior wall of the urinary bladder, and Dr. Geisinger's remarkable interpretation of his cystoscopic findings had said everything suggestive of the diagnosis except the actual words.

Fig. 5. Cystogram—Antero-posterior view. Moth-eaten appearance of upper curvature.

ETIOLOGY

When we come to consider the more likely etiological factors for the establishment of vesical mural abscess, the following occur as contributors:

1. *Invasion from the bladder cavity* would concern those lesions of the mucosa, permitting microbic ingress, trauma, in-

strumentation, cystoscopy, electro- and thermo-coagulation of tumor, and the treatment of stone, and diverticulæ, which, by stripping up the mucosa, may allow of an escape of purulent contents into the actual bladder musculature. We had the opportunity recently to report a case of ruptured extravesical diverticulum, presenting in the left lower quadrant, operation showing the small vesical opening, and numerous other smaller diverticulæ bulging here and there externally through the separated muscle bundles.

2. *Invasion by the blood and lymph stream,* bearing germs, and toxins, as one might note in syphilis and in the metastatic deposits of prolonged septic states, such as pneumonia, empyema, typhoid, etc., also from parasites, among the more prominent of which are bilharzia hemotobia, filaria sanguinis hominis, echinococcus, and the protozoa psorospermia.

3. *Invasion from below.* It is not far afield to visualize transmural bacillary infection arising in the rectum, prostate or the seminal vesicles, involving the bladder wall, by continuity of structure. It is the dense unyielding fascia of Denonvilliers that doubtless prevents many ischio-rectal abscesses from spreading rapidly upwards by virtue of its resistant, double leaved barricade, that so effectually guards the pelvic organs. Both the prostate and the seminal vesicles are in intimate touch and fuse with the bladder wall. Abscesses of these structures could be directed along any line, but would concern essentially the bladder floor! Our case had to do with the summit of the bladder!

4. *Invasion from the peritoneal cavity.* Abscesses originating in the tube or ovary or other intra-abdominal structures, as the appendix, Meckel's diverticulum, colonic diverticulum and epiploitis may adhere to the peritoneum and posterior wall of the bladder and ultimately form an abscess in the musculature of the bladder, such as illustrated in the case reported by Orfilla.

5. *Invasion from above* concerns particularly the pathology of the organs normally found in anatomical relationship with the bladder, or the pathology of organs which, when situated near or about the bladder, are in an abnormal or aberrant state. Periostitis, ostitis, or osteomyelitis of the symphysis pubis may involve the bladder wall. An infection or abscess of the properitoneal structures, and the space of Retzius in particular, may

spread to incorporate the muscles under consideration, and infection originating in an aberrant or ectopic kidney, ovary or testicle, or infected dermoid, may likewise have an incriminating

Fig. 6. Multiple cysts of urachus, the lowest one bursting among the muscular fibers of the bladder wall.

influence upon its neighbor, the bladder. It is, however, the urachus that we wish strongly to indict as the actual cause of probably all cases of abscess of the bladder musculature found throughout its summit, vault, anterior, posterior or lateral excursion.

ANATOMY

The urachus is the adult remains of that rather complicated fetal structure, the allantois, and its duties in embryological development are manifold and exacting. It continues patent through the second or third month of fetal life, when its proximal two-thirds atrophies from the umbilicus to the summit of the bladder, while its distal one-third is designed to remain patent, indeed to form that highly organized structure, the urinary bladder. This tube has a circular and longitudinal coat of non-striped muscles, which are continuous with the oblique fasciculi of the bladder, and its lumen is lined with several layers of paved, stratified, transitional epithelium, histologically identical with that of the bladder, and about it is an envelope of connective tissue more or less well defined. The normal diameter of this cord is 1 millimeter. At a definite period in its physiologic and embryologic activity, it is called upon to assume, as preordained, a rather unusual and double duty, that of (1) immediate proximal atrophy, and (2) distal dilatation, and should it falter in an immediate and accurate response, however slightly, an abnormal state is inaugurated. The obliteration does not take place uniformly throughout, but is interrupted, so that at given points here and there there are segments of this tube which, possessing its lining epithelial, refuse to close. Small cysts are the natural outcome of this epithelial activity, and the cysts may be single, multiple, large or small, but are usually spindle-shaped with the long axis of the tube. Protected anteriorly by the heavy abdominal muscles, cysts may be carried unconsciously for years, until ruptured traumatically, during pregnancy, or by violent muscular effort. Hematogenous implant means abscess, and stone is not uncommon, there being a case reported of the "abdominal rosary," in which multiple stones could be felt from the umbilicus to the symphysis. In the distal segment (the bladder), abnormal conditions are likewise seen, from the indecisive urachal aberrations, such as the restricted bladder and partitioned bladder, a case of which Benedict reports, the microscopic examination showing a distinct partition to be of smooth muscle fibers. According to Begg the distal centimeter of the urachus runs an intramural course in the bladder wall, and it is revolving about this anatomical fact that abscess formation as the result

of an infected cyst must be incorporated in the muscle bundles forming the dome of the bladder.

Zaks says that "the leaking umbilicus" and urachal cysts are due to a urinary empediment from congenital stricture of the

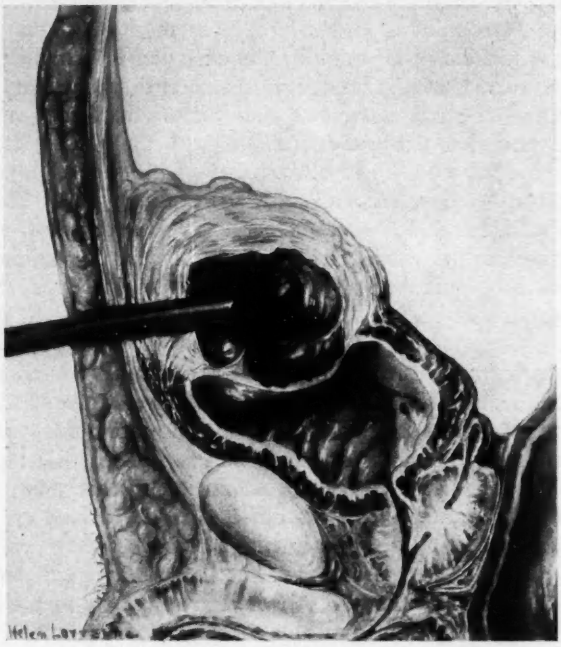

Fig. 7. Abscess located in the wall of the bladder. Drainage tube inserted.

urethra, tight phimosis, etc. This being the case, the male should have the majority of cases. He even thinks, in those cases in which this obstacle cannot be discovered, that it had been there but had disappeared later. Ribbert conforms with this point of view. He observed a ten year old boy, who had a urinary fistula in the umbilical region. Operation revealed an hypertrophy of the median lobe of the prostate, causing an acute closure of the posterior urethra.

In order to obtain some information regarding the etiology,

investigations upon animals were undertaken. Robinson's findings upon pigs, Bland-Sutton's upon moles, and Gurlt's upon horses, yielded several similar anomalies. Although these investigations showed the possibilities of such conditions in these animals, they did not throw any light upon the etiology of the affection.

The innocuous desuetude of the atrophied urachus is of but little moment surgically, but its pathological state does concern us, and may give rise to distressing and alarming phenomena requiring surgical intervention.

FREQUENCY

Uritz examined seventy-four bodies for urachal cyst, and found twenty-four undoubted instances. Legneu mentions 100 cases: 75 per cent women and 25 per cent men.

AGE

Weiser reviews the history of eighty-nine cases, and finds that cysts occur between twenty and forty, more commonly in the female, in the proportion of three to one. The average age of the cases investigated by Morse was 43.7 years.

SIZE

These cysts may be microscopic, or, as in the case of Delore and Crotte, it was the size of a nine months' pregnancy. Rippman's case, reported by Cullen, held 52 liters.

PATHOLOGY

The urachus possesses epithelial, muscular and connective tissue coats, each one of which may give rise to a benign or a morbid response. The following types of an abnormal state have been reported: cysts, calculus, myoma, fibroma, fibromyoma, dermoid, papillary carcimona, adeno-carcinoma, squamous carcinoma and sarcoma, likewise tuberculosis and echinococcus. Begg calls attention to the marked tendency of the epithelial lining of the urachus to proliferate outward into the surrounding connective tissue.

According to Means (J. W.), the cystic contents are straw-colored, of low specific gravity, and alkaline in reaction, although distinct urinary characteristics have been found in densely encapsulated closed cyst formations.

Begg reports the dramatic case of Paget, who, eighty-three

years ago, passed his finger down through the umbilicus and hooked out a ring-shaped calculus from the bladder. He likewise refers to a case of Mikulicz, who, thirty years ago, made a cystoscopic examination of the bladder through the umbilicus, the urethra being too small to admit the cystoscope.

Cases of "leaking umbilicus" have been frequently reported. This condition is simply a proliferating cyst of the urachus, near the umbilicus, which can discharge its contents and products more easily along the course of the urachal fibers to the navel, than by bursting through the more resistant belly wall. If we imagine this cyst located at the distal end of the urachus, next to, or incorporated in the musculature of the bladder, we can probably visualize, even more easily, how the traumatic escape of such a cyst, or abscess, would be encouraged to gravitate downwards among the fibers of the bladder muscles, which, undergoing its expulsive milking efforts, would invite the flow to be established in its midst.

Cases have been reported in which pus from an appendix, liver abscess, and ovarian cyst has discharged through the umbilicus. Bile, gallstone and echinococcus have likewise been reported escaping at this cicatrized hiatus.

Rotter reports a case of papillary carcinoma of the bladder that invaded a urachal cyst which had been present from birth, and Hoffman reports a case of just the reverse, in which a primary carcinoma developing in a urachal cyst invaded the bladder.

Goebel refers to a patient who had bilharzia infection of a patent urachus, causing a malignant carcinoma which later involved the bladder.

Cyst formation of the urachus is an established surgical entity, and its morbid retrogression is not infrequently encountered. It would appear that any history or physical evidence of a "leaking navel" should put the physician on guard for the presence of a urachal tumor which by virtue of its anatomical relationship is easily hidden behind the abdominal wall.

DIAGNOSIS

Whether the cyst be clean or contaminated, its traumatic rupture directs the extravasation from the lower segment downwards, towards and between the muscular fasciculi of the blad-

der, the circular coat is separated from the longitudinal, the stripping process proceeds slowly, and the rather insensate bladder complains but little of this progressive pathological process. Dysuria and retropubic or abdominal pain, particularly aggravated by extension of the trunk, and an indefinite tenderness in the lower quadrants should be of more than passing significance. Temperature, leukocytosis and rectal examination are not decisive, but it is by careful and repeated cystoscopic investigations that the diagnosis may be reached. Depending upon the actual location of the mural abscess, the vesical mucosa bulges into the bladder cavity. It is hyperemic, and does not become blanched on extreme water distention. The cystogram is of peculiar merit, and a side view should pick up the asymmetrical shape, which is more pronounced in the larger abscesses. This intravesical flattening may in certain instances be laterally placed, which would require a series of cystoscopic examinations and X-rays to definitely located. We wonder how many so-called diverticulæ, well towards the summit of the bladder, communicating by a pin-point opening only, have been misinterpreted, a heavy pyuria having been attributed to an intravesical rupture of a prostatic abscess, or indeed to a kidney lesion, the presence of a mural abscess never having been suspicioned. There is with the intense pathology a fixation of the bladder. Its emptying power is reduced, so that residual urine should be encountered in the bladder, contaminated with red blood cells and white blood cells from the intense congestion and hyperemia of the vesical mucosa.

DIFFERENTIAL DIAGNOSIS

Myoma and sarcoma of the muscular dome, and extensive carcinoma of the mucosa are apparently the conditions with which mural abscess could be confounded. Minute consideration of the temperature and leukocytosis, the character and location of the pain, with a careful history, and repeated X-ray reports of the cystogram go very far towards helping us in our surgical opinion.

TREATMENT

The suprapubic extraperitoneal attack is the route of choice, the essentials in which should be to violate neither the peritoneal or bladder cavities, and the insertion of a soft tube for drain-

age between the two into the abscess pocket. The low median, rectus and indeed the gridiron-appendix incisions give access for the palpation of the urachus during any abdominal operation, and the routine investigation of this structure may give knowledge of a state of affairs leading to a brilliant diagnosis in the future of some obscure intra-abdominal lesion.

BIBLIOGRAPHY

ALTMANN, FRANZ: Zur Kenntnis der Cysten an der hinteren Blasenwand beim Manne. Ztschr. f. urol. Chir., Berl., 1928, xxiv, 438-447.

BALDWIN, J. F.: Large cysts of the urachus with report of two cases. Surg., Gynec. & Obstet., Chicago, 1912, xiv, 636.

BEGG, E. C.: Urachus and umbilical fistulæ. Surg., Gynec. & Obstet., 1927, xlv, 165-178.

BENEDICT, P.: Abces de la paroi vesicale. Rev. Soc. Med. Argent., Buenos Aires, 1904, xii, 595-598.

BENSON, H.: Abscess in wall of bladder which pointed externally. Trans. Acad. Med. Ireland, Dublin, 1883, i, 355.

BUTRUILLE, A.: Abces interstitials de la vessie. Jour. d. Sc. Med. de Lille, 1880, iii, 543-545.

DELORE, H., and COTTE, G.: Des gros kystes de l'ouraque. Rev. de chir., Par., 1906, xxxiii, 403-430. Also, Abstr.: Lyon Med., 1905, cv., 373-375.

DUMONT: Observation sur un abces vers le col de la vessie. Actes Soc. de Med., Chir. et Phar., Brux., 1797, i, 162-164.

KRUER: Fistula of urachus. Deutsche Med. Wchnschr., 1920, xlvi, 885.

MATTHIAS, F.: Vereiterung des persistierenden Urachus mit Durchbruch in die Blase und in die Bauchdecken. Beitr. z. Klin. Chir., Tubing., 1904, xlii, 339-345.

MEANS, J. W.: Cysts of the urachus; case report. Ann. Surg., 1916, lxiv, 53.

ORFILA, J. R.: Poisalpinx abierto en la veziga; exterpacion, sutura vesical; curacion. Rev. med. d. Uruguay, Montevideo, 1913, xvi, 295-299.

NEUGENBAUER, G.: Formation of calculi in cysts of the urachus. Deutsche med. Wchnschr., 1928, liv, 1421-1422.

PATEL, M., and LABRY, R.: Large closed cysts of urachus. Gynec. et Obstet., 1925, xii, 449-463.

PLATOU, PEDRO: Suppurative cellulitis of the bladder wall. Long Island Med. Jour., Nov., 1926.

RANKIN, F. W., and PARKER, B.: Tumors of urachus; with report of seven cases. Surg., Gynec. & Obstet., 1926, xlii, 19-27.

ROCHET: Les absces de la vessie chez les vieux urinaires. Arch. Prov. de Chir., Paris, 1897, vi, 515, 597.

ROTTER: Entfernung einer Urachuscysts, welche mit einem Carcinom der Blas in Verbindung stand. Deutsche med. Wchnschr., Leipzig u. Berlin, 1898, xxiv, Ver. Beil., 10.

SEN, G. L.: Abscess bursting into urinary bladder. Med. Rec. Calcutta, 1890, i, 175.

WEISER, W. R.: Cysts of the urachus. Ann. Surg. Phila., 1906, xliv, 529-552.

WITTE, R. F. A.: Ueber Blasenwand-Abscesse. 80 Griefswald, 1896.

WILLA, F.: Tumore, dell uraco; resezione estesissima delle pareti abdominali e dell' omento; resezione della cupola vesicale. Gazz. Med. di Milano; 1902, i, 65-69.

MULTIPLE CYSTIN CALCULI IN THE LEFT KIDNEY WITH OBSTRUCTION AT THE URETEROPELVIC JUNCTURE AND MULTIPLE CYSTIN CALCULI IN THE BLADDER IN A BOY OF FOUR YEARS

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During recent years medical literature has contained numerous articles concerning urologic conditions in children. A review of these indicates that urinary lithiasis is frequently observed in children. In a paper which appeared in Minnesota Medicine in 1922, one of us, after reviewing the literature and obtaining data from urologists and pediatrists, was able to collect 208 reports of infants or children under ten years of age with urinary lithiasis. At that time we recognized diet and infection as possible factors in the production of these calculi. Since the many recent improvements in the child's size cystoscope which permits bilateral ureteral catheterization and pyelography, most urologists have recognized many congenital anomalies occurring in the infant urinary tract. By interfering with drainage, these have undoubtedly contributed to the formation of urinary calculi.

Dr. H. O. Mertz, in his paper in the Journal of Urology in 1928, called attention to congenital changes in the urinary organs and their influence upon the occurrence and the treatment of pyuria in infancy and childhood. Before the publication of Dr. Mertz' paper, but more particularly since that time, we have been struck with the frequency of congenital changes in the urinary tract in a great number of infants that we have examined. These congenital changes have been noted in practically every child with urinary lithiasis that we have examined during the last few years.

In the Journal of Urology for November, 1925, one of us reported a child with bilateral renal lithiasis who had a congenital

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anomaly at the ureteropelvic juncture. In the Medical Sentinel for November, 1929, we reported a girl, aged seven years, who had congenitally deformed ureters with an unsuspected stone in the right lower ureter which had not produced pain.

Fig. 1. Roentgenogram showing one large and many small shadows in left kidney area, and multiple shadows in bladder area.

The case we are reporting herewith is of unusual interest because of the large number of pure cystin stones found in the kidney and bladder. In addition, this child had an obstruction at the ureteropelvic juncture with possibly an anomalous vessel crossing this area which we believe was a factor interfering with drainage, thus predisposing the formation of these calculi.

Although calculi in the kidney are frequently reported in chil-

dren, calculi in the ureter are less frequent and those found in the bladder occur rarely in our experience. One of us, who has conducted a pediatric practice for many years, has not observed a single child with stones in the bladder. Our data obtained from the literature indicate that 57 per cent of children under fifteen years of age with urinary lithiasis had calculi in the bladder. (Many of these reports are found in foreign literature.) Most stones found in the bladder, however, occurred either with

Fig. 2. Cystin stones removed from bladder.

bladder diverticuli, congenital atony, or with congenital obstruction at the bladder outlet. Few of these reports contain a history of ureteral pain. It is therefore unusual to find stones in the urinary bladders of children that have been passed through the ureter from the kidney.

The case we are reporting is that of a boy of four years whose history and physical findings were as follows:

D. M., a male child of four years, was referred by Dr. Thomas Flynn of Redwood Falls, Minnesota, with a tentative diagnosis of stone in the bladder.

His presenting complaints were frequent, scanty, bloody urination with severe pain. At about hourly intervals the child would assume the knee-chest position, clutch at his penis, perspire freely, and, with severe straining and loud crying, finally succeed

in passing a few drops of bloody urine. He had had but little sleep for several days and there was almost complete anorexia.

Up to the age of seventeen months his history was that of a normal infant. At that time, accompanying an attack of influenza, he passed bloody urine for a few days. At about three years of age, the urine again showed blood on several occasions, but there was no complaint of pain. Two months before we observed the

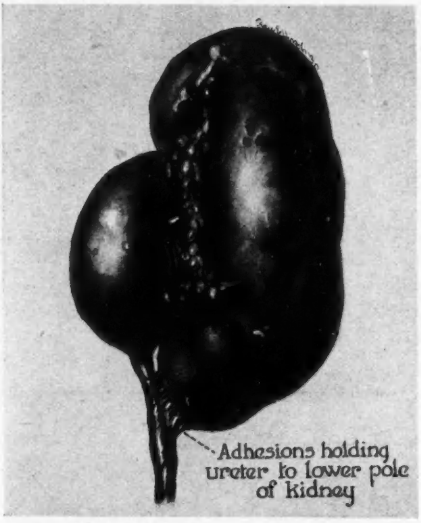

Fig. 3. Unopened kidney showing adhesion of ureter to lower pole and large distended pelvis.

boy, he had a grippal infection. This was repeated two weeks before we saw him and was followed by an abrupt onset of the aforementioned symptoms. There was no history of injury, systemic disease, such as typhoid, or chronic pyuria.

On physical examination, the child showed emaciation and great prostration. There was a daily temperature elevation to 101.5 degrees. The tonsils were enlarged and injected, and there was moderate cervical adenitis. There was a left otitis media which progressed to a rupture of the drum, with discharge of pus on the tenth day in the hospital. The von Pirquet test was negative.

The urine was scanty and contained a large amount of blood and pus.

Most pediatrists who have collaborated with urologists have recognized the ease with which complete urologic examinations may be made upon children. The X-ray and the cystoscope may be used in every instance where urinary pathology is suspected in infancy or childhood. The X-ray in this instance revealed one large and numerous small shadows over the left renal area. Over the bladder we were much surprised to find a nest of shadows ranging

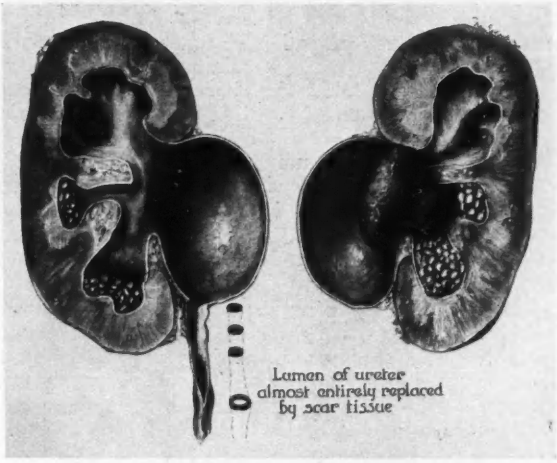

Fig. 4. Kidney and pelves bisected showing the multiple stones with large hydronephrosis and obstruction to the ureter.

in size from a green olive pit to a shelled almond. The shadows over the bladder area were interpreted at first as feces in the bowel, because of their great size. An enema was given and the X-ray repeated. The shadows remained in a slightly altered position and a diagnosis of multiple bladder calculi was made. Because of the rarity of the latter condition and because we were very anxious to determine the function of the right kidney, cystoscopy was advised and undertaken. The meatus of the urethra had to be dilated somewhat, but after this was accomplished, the cystoscope passed easily into the bladder. No bladder neck obstruction was found. Five stones were resting on the trigone of the bladder. These had smooth surfaces, and were grayish in color, with a

slightly yellowish tint. No diverticulum of the bladder could be found, but cystitis, graded 3, was present throughout. The ureteral orifices were gaping, as is usual in children, and cloudy urine could be seen from the left. That from the right appeared clear. Number 5 French whistle-tip catheters passed through both ureters without meeting obstruction. Very cloudy urine was obtained from the left side and indigocarmin returned after eight minutes and concentrated very slowly. The urine obtained from the right kidney was clear and indigocarmin was returned in three minutes and concentrated rapidly.

It was evident from the urologic examination that there were multiple calculi in the bladder, severe cystitis, and multiple stones in the left kidney with diminution in function from this side.

In our experience, congenital conditions in children, as well as in adults, are frequently bilateral. Therefore, we considered it necessary to make a pyelogram of the right kidney in order to eliminate this possibility.

The boy was very ill from his distressing bladder symptoms, so we decided to recheck the right kidney later, and advised a suprapubic cystotomy immediately following the cystoscopy. The continuous suprapubic drainage following the cystotomy for removel of multiple stones, greatly relieved this boy, so that his convalescence was rapid.

The sixteenth day following the cystotomy, we decided to go ahead with the nephrectomy, at which time the suprapubic wound was practically dry. The kidney was delivered easily, although the upper pole was somewhat adherent. The pelvis and ureteropelvic juncture were much distended down to the lower pole of the kidney, where adhesions bound the ureter and held it very near the lower pole. During our first survey of the kidney and ureter we did not observe an anomalous blood vessel crossing the ureter. When the adhesions holding the ureter to the lower pole of the kidney were loosened, the ureter wall at this point was found to be thick, and contained much scar tissue. The ureter was cut and tied a few inches below the obstructed area in the usual manner. It was not dilated, and looked and felt normal.

The pedicle of the kidney was easily found, was grasped with a pedicle clamp and the kidney removed. The pedicle was tied in the usual manner with two strands of chromic gut. When the pedicle clamp was removed we were much surprised and much alarmed to observe very brisk bleeding, evidently arterial. The pedicle, which had been grasped with a Carmalt forceps, following the removal of the pedicle clamp, was inspected, but the ligatures seemed to be in good position and we could not see a bleeding point or area in the pedicle stump. The hemorrhage could be controlled by packing, but when the packing was removed the hemorrhage

recurred, and was as brisk as before. Eventually a small blood vessel was seen in the area occupied by the lower pole of the kidney. This was grasped with forceps, tied, and the bleeding stopped.

In spite of the fact that we carefully examined the ureter at the obstructed portion, we did not observe this vessel when the dissection was made. When the gross specimen was studied, how-

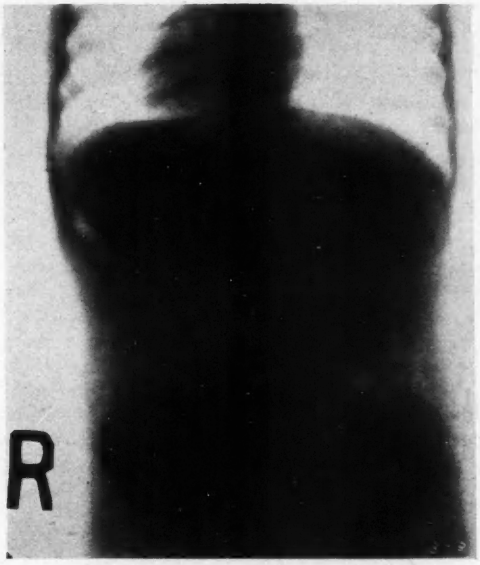

Fig. 5. Roentgenogram of kidney and bladder areas following operation. No stone shadows.

ever, a small artery leading to the lowermost portion of the pelvis and the lower pole of the kidney was found. This may have been the cut end of the vessel that caused the bleeding, and may have been an anomalous vessel.

The patient made an uneventful recovery following the nephrectomy, and returned home in twenty-one days. An X-ray examination of the kidney, ureters and bladder was made before the patient left the hospital, which revealed no evidence of shadows that might be interpreted as calculi remaining in the urinary tract. Two months later he was reported to be active, comfortable and thriving.

A chemical analysis of the removed calculi is described as fol-

lows by Dr. R. H. Rufe, of the Department of Physiological Chemistry of the University of Minnesota:

"The physical characteristics of these calculi were different from those usually described for cystin calculi, except, perhaps, for the presence of numerous smaller stones. The calculi were hard, but brittle, and easily ground to a fine white powder. When one of the large bladder stones was sawed through, the structure could be discerned as concentric layers of a white, amorphous-appearing substance with a rather large nucleus of a pale yellow, crystalline material, similar to the very large pelvis stone.

"Preliminary tests for uric acid, calcium and phosphorus were negative. The powdered calculi burned with a small, pale blue flame with practically no residue, but with a peculiar, sharp odor. An ammoniacal solution of the powder showed on evaporation myriads of six-sided, flat crystals characteristic of cystin. The cyanide-nitroprusside reaction, as described by Brand, Harris, and Biloon, was strongly positive.

"Analysis of the outer shells of the bladder calculi, their nuclei, and the large stone from the pelvis of the kidney, was made for cystin and for total sulphur. The smallest stones were not analyzed quantitatively, but they gave strong qualitative tests for cystin. The modification of the Sullivan reaction, as described by Brand, Harris and Biloon, was used for the cystin determinations. All three samples gave over 100 per cent cystin. A sulphur analysis of the cystin used in the preparation of the standards showed a maximum content of 92 per cent cystin, using the factor 3.75 in converting g. sulphur to g. cystin, so the calculi had a higher content of cystin than the standard. Total sulphur was determined, using Benedict's sulphur reagent to oxidize the sulphur, and the benzidine method in determining the sulphate formed. Drying the powder obtained from grinding the calculi at 100° for three hours caused less than 0.5 per cent loss in weight."

Our study of this patient's history, together with the urinary and operative findings, and the data obtained from examinations of many other children with urologic conditions, emphasizes the following:

1. Congenital changes in the urinary tract by interferring with drainage may be a factor in the production of urinary stones in children.
2. Urologic examinations may be made just as easily and as completely with children as with adults.
3. Urinary calculi occur frequently in children.
4. Pure cystin stones may occur in the urinary tract of children and may cast a very distinct roentgen-ray shadow.

DISCUSSION

DR. A. J. CROWELL (Charlotte, N. C.): I doubt very much the advisability of having done a nephrectomy in the case reported by Dr. Thomas. There will almost certainly be a recurrence of stone in the remaining kidney. I think if he had alkalinized that child's urine and kept it strongly so the stones would have disappeared and he would have saved the kidney. Of course, the diet is a very important problem in addition to keeping the urine strongly alkaline.

It is a known fact that cystin can be dissolved in an alkaline solution. When I reported, several years ago, the disintegration of some large stones in both kidneys, it was thought almost impossible. The truth was demonstrated by X-ray pictures taken over a period of nine months. Some of our members were of the opinion that cystin stone would not cast a shadow and could not be demonstrated by X-ray. We proved they would cast a shadow and disappear under alkalinization of the urine and proper diet.

In addition to alkalinizing the urine in this case, we used hot mercurochrome as an antiseptic on account of a virulent kidney infection. This may have been worth something in helping bring about disintegration of these stones.

Unless we strongly alkalinize the urine in these cases of cystin nephrolithiasis, we are more than likely to have recurrence. We have found six or seven cases of cystin-nephrolithiasis during the last six or seven years in our clinic, and we have been very careful to do no operative procedure in these cases without first having used every known means to bring about disintegration and sustain normal kidney function.

DR. WILLIAM F. BRAASCH (Rochester, Minn.): I would like to recite the experience we have had in the treatment of cystin stones. I recall distinctly two cases where we tried the method of alkalinizing the urine as suggested by Dr. Crowell. We kept the patients under observation for six months or more and gave them everything we could to make the urine just as alkaline as possible. In spite of this we had no results in either case and operation was necessary.

Following operation, however, we continued the alkalinization and in one case there has been no recurrence. I question very much whether alkalinization of the urine would be sufficient to dissolve the stones in most cases.

DR. ROGER C. GRAVES (Boston): I was very much interested in Dr. Thomas' case. A number of years ago I reported a series of eight cases of cystinuria occurring in a single family. The study began with one indivdual, whom I saw at the Peter Bent Brigham Hospital in 1922 and from whom I removed a cystin stone in the pelvis of the right kidney.

There were a number of very interesting features in connection with that case that apply to this discussion. In the first place, in this particular patient the stone was not shadow-casting in the X-ray film. It was detected, rather, by a vacuole in the pyelogram, giving the appearance of a bubble of air rather than the increased density that one would ordinarily find from a stone.

In attempting to throw some light on this phase of the diagnosis of cystin stones, I reviewed the literature very carefully and found a good deal of variance in the opinion as to whether or not these calculi are opaque to the X-ray. I then made some paraffin-coated capsules of pure cystin and swallowed them, and swallowed capsules of bismuth of different size at the same time for control. In plates made at once of the stomach region it was impossible to see any evidence at all of the cystin capsules, although I had packed them very solidly with pure cystin powder.

It seems that the question as to whether or not they will show shadows in the X-ray film has to do with two factors: first, whether the stone is pure cystin, or whether it also contains a shadow-casting salt; second, the texture of the particular stone. Some pure cystin stones, for example, may cast shadows if they happen to be formed of very closely packed molecules, whereas others, if they chance to be more loosely knit, as indeed many of them are, will escape the ray.

After discovering that my patient had a cystin stone, I was enabled to study, through her coöperation, the other members of her family in her own and the next generation. She had two or three sisters and they all had several children. In the

entire family I found eight cases of cystinuria. The patient that I have spoken of was the only one who had ever formed a stone.

I think that throws a little light on the objection Dr. Crowell raised to Dr. Thomas' nephrectomy. I should feel that Dr. Thomas need not expect necessarily a return of stones in the other kidney in the boy. The woman from whom I removed the cystin stone eight years ago has not had recurrent calculus formation. She did have, on occasion, showers of small concretions or cystin sand, but it has been a number of years now since I have heard of even that. She certainly never has formed another stone which has required any sort of surgical or cystoscopic intervention, as far as I know.

Another feature of interest in this family of cystinurics, bearing somewhat perhaps on the general question as to the relationship between stones and infection of the urinary tract, is that the patient who had the cystin stone and required pyelotomy for its removal, had a perfectly sterile urine, whereas one of her sisters who had a severe chronic colon-bacillus pyelitis with a constant bacteriuria, and who also had definite cystinuria, never made stones.

The question of treatment, I agree with Dr. Braasch, is less simple than it sounds in theory. Cystinuria is a disease of metabolism. You cannot correct this defect in sulphur metabolism by the mere giving of alkalis. We found in studying our group that it was quite out of the question to do anything more than palliate the situation by alkaline feeding. In the woman who had the cystin stone, we maintained alkalinization of the urine by high doses of sodium bicarbonate, but we found that the amounts necessary to produce this effect were large enough to interfere seriously with digestion. This patient refused to coöperate to the extent of going on indefinitely with that sort of treatment.

Dr. Harry A. Fowler (Washington): I had occasion several years ago to observe a patient from whom a large cystin calculus had been removed from the bladder. The composition of this stone was not known at the time, and was only accidentally discovered during a routine examination of a series of urinary calculi.

Having found that this stone was composed of cystin, we

then communicated with the patient and found that he was excreting cystin in the urine.

An effort was made to check up on other members of the family. We succeeded in having three of them come under observation, but in none of those three was cystinuria found.

This particular case was interesting, because the patient continued under observation during a considerable period, and he added to our collection of cystin stones by forming calculi in the bladder, which were removed at various times. I think we have four stones which we removed from his bladder subsequent to the first time he came under observation.

At the time, we did not know the effect of alkalinization upon the production of stones, so no effort was made to control the reformation of stones. But it does show that there must be some difference in the reaction in these cases. In this particular instance there was a definite tendency toward reformation of cystin stones.

Dr. George R. Livermore (Memphis): We had one case in a child, a boy about five years of age, whose only symptom was incontinence. His mother said he did not complain of anything but she brought him into the hospital because he was constantly leaking urine. The interne attempted to pass a catheter, and met obstruction in the prostatic urethra, so he sent the boy up to the X-ray department and had a plate made. It showed a dumbbell-shaped calculus, the handle in the internal meatus, one rounded end in the prostatic urethra, and other in the bladder.

We found a marked pyuria, which after removal of the stone cleared up entirely.

We have had two young children in the hospital, only recently, sent from the Crippled Children's Hospital, both of whom gave a history of some chronic infection, one of them from a very extensive burn and the other from an osteomyelitis of the femur and tibia. Both of those cases have multiple stones in the kidney, one of them bilateral and the other unilateral.

Dr. Gilbert J. Thomas (Minneapolis): As to the question of operation in this case I feel we were forced to take the stones out of this child's bladder.

Secondly, I must admit I did not know these were cystin

stones. There is quite a difference of opinion, particularly whether a pure one, as Dr. Graves has indicated, will cast a shadow. I did not at all think these were cystin when we started. While the child was under the same anesthetic for the cystoscopy, I immediately opened the bladder and took the stones out and thoroughly drained it, and even then I wasn't suspicious that we were dealing with stones that were so purely cystin.

It was evident from the urologic study that the function of the left kidney as estimated with dyes and the amount of pus, was practically destroyed. The large stone, and the definite obstruction which we found at the ureteropelvic juncture after the specimen was removed, seemed to justify our procedure.

Dr. Graves mentions cystinuric families, which is a very interesting point. We have looked up this rather curious fact to some extent. Cystinuria does occur in families. It is a definitely metabolic error of some sort, and we, in reviewing the literature, were not sure that alkalinization helped very much. In this child it was rather difficult to get a clean-cut history as to what its feeding had been. Both the mother and father spoke no English; they were Polish and had been in this country but a short while. This boy had a younger brother or sister who was not available for examination. The mother and father, as far as we could tell from checking the urine, were negative.

I passed the stones around for a particular purpose. The chemist, who is, we believe, an excellent chemist, finds that these are the purest cystin that he has been able to find. As I mentioned in my paper, they are purer than the standard that he used for testing, and he thought they were very unusual. If they are pure, the question of their showing such a distinct shadow is of interest.